# DISEASES
OF THE
# AIR BRAKE SYSTEM.

PAUL SYNNESTVEDT.

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OF THE

# Air Brake System

THEIR CAUSES, SYMPTOMS AND CURE

BY

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# ILLUSTRATIONS.

# PREFACE.

In submitting the following work to the railroad public it is proper that the author should begin with a few words of explanation.

He does not wish, like many authors, to apologize for what he has done, and he does not wish to belittle his own exertions, for the preparation of the work has cost considerable labor; but he does wish to ask the indulgence of critical readers, submitting it as a truth, self-evident, that no man's work is infallible, and acknowledging in all humility that many air-brake doctors, some of them in their lines more competent than he, may find fault with many of the prescriptions that he has written.

In spite of all this, however, he is not without hope that his work, incomplete and imperfect though it may be, will, in a measure at least, supply a long felt want.

To those desirous of becoming good air brake "doctors," he would say: Always use your *reason* first and your HANDS afterward.

Treat your case just as a doctor does his patient, first finding out the nature and cause of the disease, and then prescribing and applying the remedy.

# DISEASES OF THE AIR BRAKE SYSTEM.

## INTRODUCTORY.

As long as a man's body is in perfect health, it causes him little or no trouble. He is not conscious that he has a brain, heart, lungs or stomach; nor has he any need to be. They perform their allotted functions without friction or inconvenience, and all goes well until "disease" begins to show itself. A *pain* appears in some particular part. Then he must needs learn the functions of that part, that thence he may discover what interference with those functions has caused it to rebel.

As long as the *air brake* system is in perfect health it gives little or no trouble. In such a condition no thought is given to its inner workings, and, in fact, there is no need of such concern. As soon, however, as some "disease" appears the case assumes a different aspect. The action of the apparatus is no longer satisfactory. The necessity then arises of locating the seat of the disorder, removing the cause, and thus curing the "disease." This requires study of the principle of operation of the whole, and the particular use of each part in its relation to the whole. As in the case of a headache from a disordered stomach, defective action of one part may be only a *symptom* of a disease in some other part, far removed as to space but closely connected in function.

While it has been necessary in arranging the following work, to treat of the various "diseases" under the heads

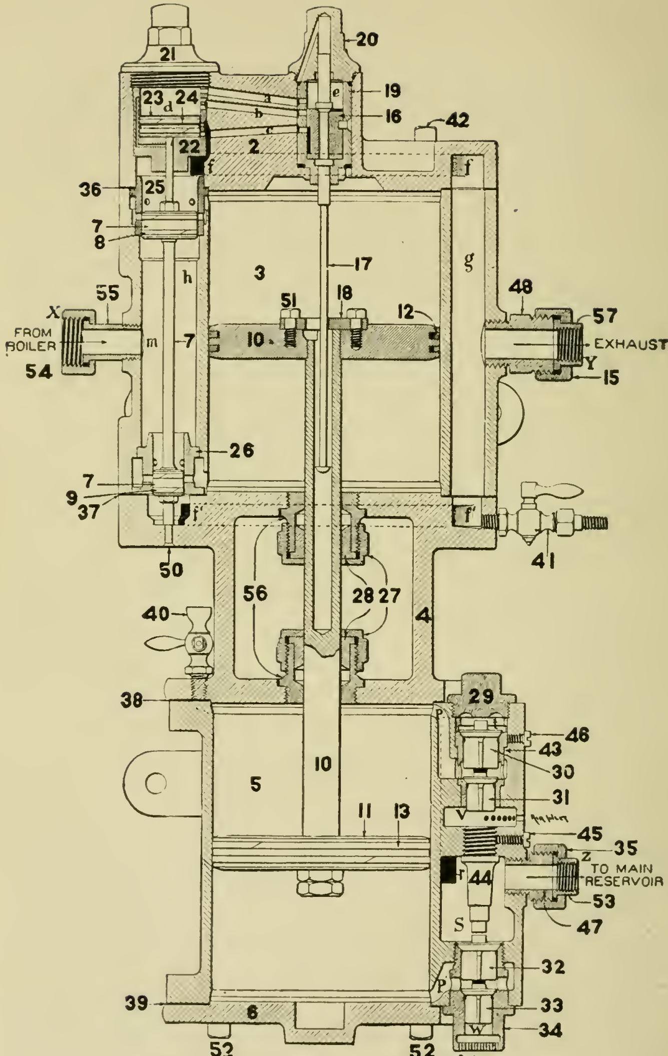


PLATE 2. WESTINGHOUSE 8-INCH PUMP.

of the individual parts of the system, it must not therefore be inferred that every part is entirely distinct from every other part. On the contrary, every part is closely related to every other part in the performance of a common use, and this fact must be kept clearly in mind in the treatment of all cases.

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# PUMPS.

## Eight-Inch Westinghouse Pump—Plate 2.

The disorders that arise in this pump may be classed under two general heads:

1st. Trouble in the upper or steam cylinder.

2d. Trouble in the lower or air cylinder.

The parts in the upper cylinder most liable to derangement are the main-valve (7), reversing piston (23), reversing valve (16), reversing-valve stem (17), and the reversing valve plate (18).

### MAIN VALVE.

Of the main valve (7), the packing rings (8 and 9), become worn so as to cause quite a blow into the exhaust, in which case they must be taken out and new ones fitted. When this is done, the bushings (25 and 26) should be carefully calipered and replaced with new ones if they are worn out of true (larger diameter in the middle than at the ends).

Quite frequently the small nut on the top of the main valve works loose and comes off, sometimes causing stoppage of the pump. This may require renewal of the valve-rod. The nut should be made to go on hard, and should be riveted fast when screwed down.

If the small stop-pin (50) gets broken or worn too short, the pump will stop because of the main-valve traveling down so far as to allow the lower small packing ring to expand below the bushing and catch. Although a little thing to repair in itself, it requires considerable work and much care. Some have done it without taking the pump apart by forcibly pulling out the main valve, drilling out the stub of the pin (50) and inserting a new one from above by means of a stick with a socket in the end. This forcible removal of the main valve will generally break the small ring or spider, or both, and necessitate their replacement.

## REVERSING PISTON.

The reversing piston (23) is generally the first thing to require attention in case the pump stops. This is due largely to the fact that when a pump is run short of oil, the reversing piston gets scarcely any on account of its location, the oil tending downward rather than upward. The rings (24) when they are loose or worn so as to open wide at the joint, should be replaced, as also the bushing, if it is out of true or worn large in the opening through which the rod works.

Often the rod breaks off just at the point where it joins the piston head. This will render the pump liable to frequent stoppage, due to the head being without a guide, traveling so far upward as to partially close the upper ports, or tilting over so as to catch.

Rapping the pump lightly on the top of the outer cap will often start it by jarring the reversing piston head down into place.

It may here be noted that a pump that requires frequent rapping to keep it going is in need of overhauling.

### REVERSING VALVE AND STEM.

The reversing valve (16) itself does not give as much trouble as the spindle or stem (17) which operates it. If the valve seat becomes badly worn, a new valve should be substituted and it should be a pretty close fit inside of the bushing. Any disarrangement of the reversing valve or spindle generally results in an erratic stroke of the pump, jumping, or "jiggling," or half stroke, caused by its reversing at the wrong time. The spindle should fit snugly, both where it passes through the bushing and in its bearing in the top cap. If badly worn in either place, the spindle, and often the cap and bushing, also, should be replaced with new ones. Another place very liable to excessive wear is where the spindle is struck by the reversing plate (18), and the shoulder and button on the spindle, and both sides of the plate should be carefully examined, especially if a pump pounds badly. The under side of the plate generally wears the most rapidly, and must not be overlooked in making an examination. If the reversing rod gets bent slightly it may rub against the plate hard enough to cause the pump to reverse at the wrong time.

Straightening the rod is of course all that is necessary to remedy this. In putting the top head on after repairing, the copper gasket should be examined to see that it does not cover the small port through which steam goes to the reversing valve cavity in the top head.

### LOWER OR AIR CYLINDER.

The parts in the lower or air cylinder most liable to derangement are the air valves (30, 31, 32 and 33). If they become worn so as to lift too far, it will result in the pump pounding. They must be replaced with new ones, having the projection on top filed down just enough to give them the right amount of lift.

Authorities differ slightly as to what this should be. Some say about 1-16 of an inch. The discharge-valves (30 and 32) should not have as much lift as the receiving valves (31 and 33).

Sometimes the valve-chamber bushings (43 and 34) become worn so badly where the valves seat that they must be replaced.

Occasionally one of the air-valves gets broken. Any difficulty with these valves can generally be detected by careful examination of the suction of the air at the inlet ports. If the air blows back at the beginning of the stroke, the receiving-valve does not seat properly. If the suction is very weak, either the discharge-valve is not seating properly or else the packing rings (13) in the main piston head are blowing. The latter difficulty, which is very common, can be detected by taking off the lower head and working the pump very slowly, holding a light under the piston head.

These rings (13), as also those in the steam cylinder (12), not infrequently require renewal.

### REBORING CYLINDERS.

Of course, when either the upper or lower cylinder becomes badly worn, it must be rebored. Putting new rings

into a cylinder which is unevenly worn does not do very much good.

Another trouble that has been found in the lower cylinder is the working loose of the nut (58) that holds the piston-head on the rod. This will either result in stopping the pump (in case the nut strikes the lower head before the piston has traveled far enough to reverse) or it will cause the piston-rod to wear into the head, constantly aggravating the difficulty. One case came under the writer's notice in which the rod had punched its way entirely through the head.

### SYNOPSIS.

In general, the various disorders of the pump of most common occurrence are:

"Stoppage" (complete). Cannot be remedied by rapping or coaxing.

"Stoppage" (temporary or occasional). Pump can generally be started by rapping.

"Pounding."

"Heating."

"Jiggling" or "Fluttering."

Unequal stroke (fast on one stroke, slow on the other).

Fairly rapid stroke, but low effective capacity (pumps little air).

### STOPPAGE (COMPLETE).

This may be due to the stop-pin (50) being broken (see page 10); the small nut on top of the main valve being loose (see page 9); the small port to the reversing-valve chamber being obstructed (see page 11); or the nut (58) working loose.

### STOPPAGE (TEMPORARY OR OCCASIONAL).

This may be due to lack of oil in the steam valves (especially the reversing-piston 23); broken reversing piston-rod (see page 10); loose nut on top of main steam-valve (see page 9); badly worn packing-rings in main steam-valve, or reversing piston; or sometimes excessive wear of the reversing-valve plate (18); (see page 11).

### POUNDING.

Pounding may be due to any one of a great variety of causes.

It may be a pounding of the steam-valves, air-valves, or main piston itself. Anything which will allow the main piston to strike either cylinder-head before the pump reverses will cause a heavy "pound." This may result from too tightly fitted steam valves or rings, or rings too loose, either causing sluggish motion in the reverse movement; dryness in the steam cylinder-valves; badly worn reversing-valve plate or stem; or too long a reversing-valve stem.

A pump may also pound if the air-valves have too much lift. This can generally be detected by a careful examination of the suction ports, to see whether the air is drawn in properly at the very beginning of the stroke.

### HEATING.

This most frequently results either from dirt or gum in the discharge passages or too much clearance of the piston in the air-cylinder. Of course, if a pump is run full speed for a long time it is sure to heat more or less, one inevitable consequence of compressing air being the accumulation of

heat. This is a case where a grain of prevention is worth a pound of cure. If a pump gets very hot it must be practically stopped and allowed to cool before much can be done to it. If notice is taken of it before it reaches what might be called the "explosive" point, a slight reduction in speed with a very little good valve oil in the air-cylinder may save further trouble.

Many have asked the writer if water should be used to cool it.

There certainly can be no serious objection to this, provided the pump be stopped before the water is poured on, so it will not be sucked into the cylinder. All scientific air-compressors used in mines or similar service are "water-jacketed," and some use a jet inside the cylinder.

A pump that has been "dosed" for some time with too much oil in the lower cylinder is almost sure to heat, simply because the air-discharge passages become clogged with gum.

JIGGLING OR FLUTTERING.

This term is used to designate a kind of jumping or short, catching stroke, and is almost always due to some trouble in the reversing-valve or stem. (See page 11).

GROANING.

This may be said to indicate lack of oil, yet it has been noted by many men that the pumps that have been getting the largest quantities in the air-cylinder are most liable to make this noise.

This fact is hard to explain. The writer will only say that a "groaning" pump is frequently helped by thorough cleaning of the air cylinder and careful use of oil thereafter.

### UNEQUAL STROKE.

This is generally caused by unequal lift of the air discharge-valves (30 and 32). If the up stroke is slower then the down stroke, valve (30) has less lift than valve (32), and *vice-versa*.

The other causes of this trouble will be found in sluggish action of the steam-valves.

### FAIRLY RAPID STROKE, BUT LOW EFFECTIVE CAPACITY.

This trouble is always found in the air-cylinder. Either the valves do not seat properly; the piston has too much clearance; the rings (13) leak, or the cylinder is worn out of true. (See page 12).

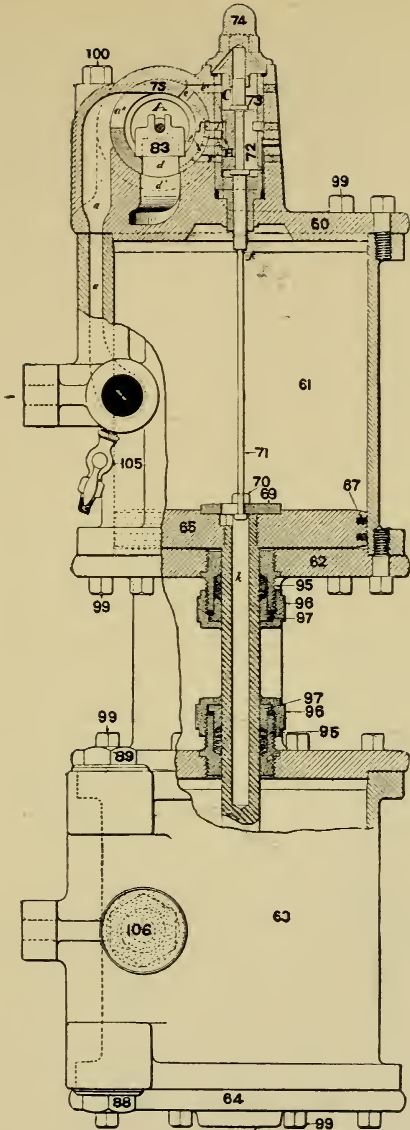



Fig. 2

Nine-and-a-Half-Inch Westinghouse Pump.—Plate 3.

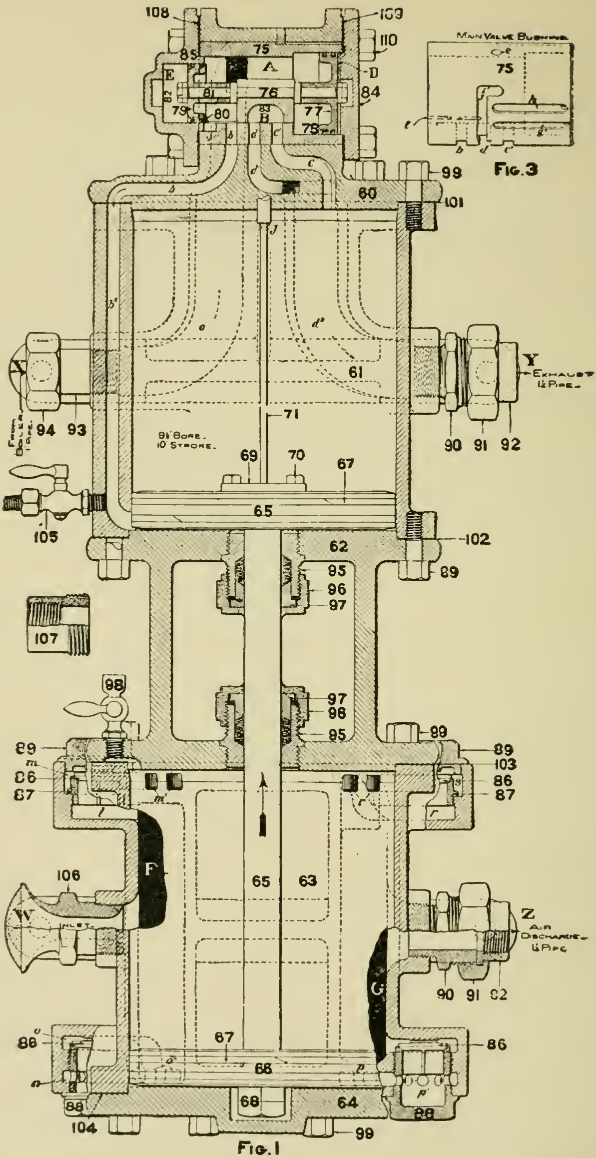

Main Valve Bushing
Fig. 3
91" Bore.
10" Stroke.
From Boiler 1" Pipe.
Exhaust 1½" Pipe.
Inlet.
Air Discharge 1½" Pipe.
Fig. 1

Plate 3 A.

## Nine-and-a-Half-Inch Westinghouse Pump—Plates 3 and 3a.

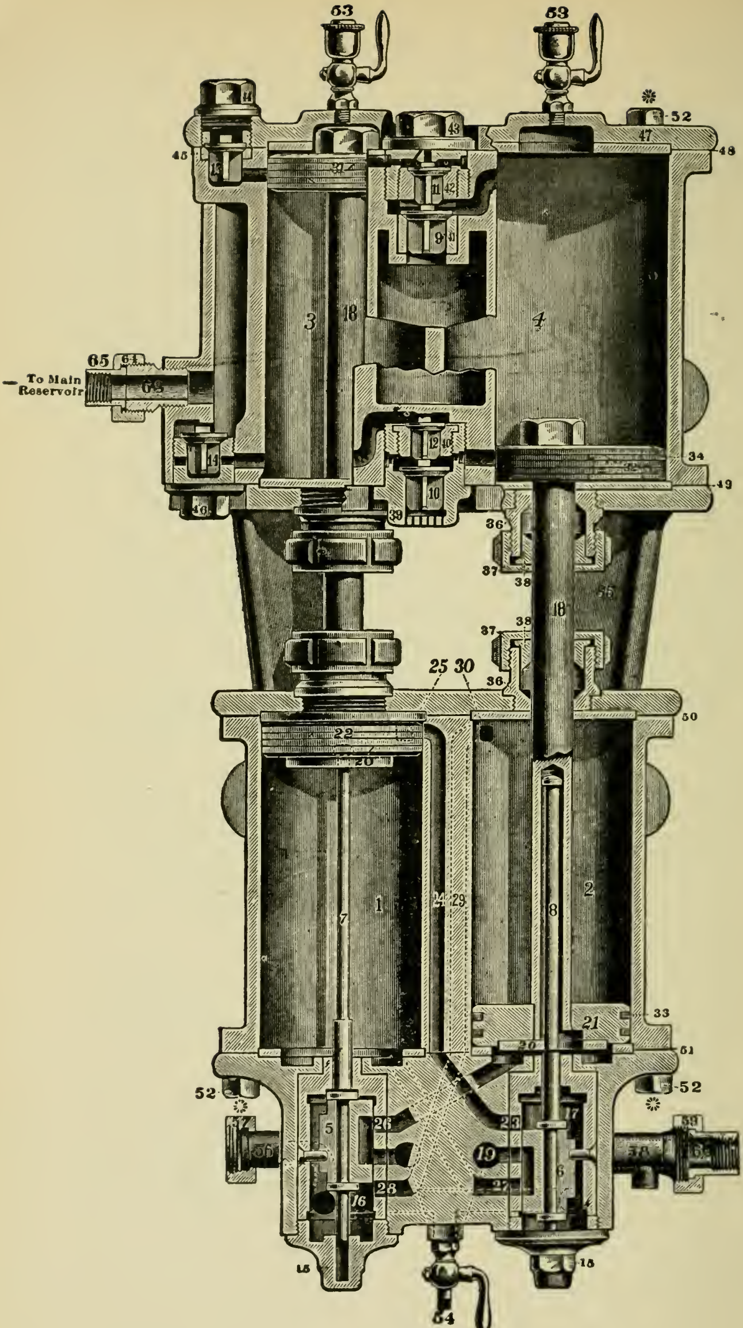
The latest design of pump furnished by the Westinghouse Company is shown in Plate 3. It has not yet been in service long enough to enable any one to write a very complete account of the disorders to which it is subject, and a few remarks concerning it will be sufficient at present.

All the valve motion for the steam cylinder is in the top head, so that in case of any failure to work properly a new head can be substituted until the old one can be fixed. There are a number of points in which this pump is similar to the 8-inch pump, and in which it will be liable to the same troubles.

It has the same arrangement of hollow piston-rod, reversing stem and valve, and a similar bushing in which this valve works, and as these parts perform practically the same function in this pump that they do in the other, any irregularity in their action will produce practically the same effect. If the reversing-valve stem is too long between the shoulder and button the pump will pound and may not be prompt in reversing, and the same thing will occur after the reversing-valve plate or this shoulder or stem become badly worn. If the distance between the shoulder and button be too small, the pump will have too much clearance and will heat in consequence.

An unequal stroke will result in case the lift of the upper and lower air-valves wears unevenly.

"Jiggling," or short imperfect stroke, will result in case any wear or unevenness causes a movement of the




New York Duplex Pump.—Plate 4.

reversing-valve (72) at any point other than the limit of stroke, when the shoulder or button of the stem is struck by the reversing-valve plate.

Of course, the small packing rings in the two heads of the differential piston will wear out in course of time and will then have to be renewed. The grooves in which they are fitted, and the bushing in which the valve works, will also wear so as to require renewal, but I have not heard of any of these pumps which have been in service long enough yet to make such treatment necessary.

### New York Duplex Pump—Plate 4.

The duplex pump not having been in service as long as the Westinghouse 8-inch pump, it is hard to find men well enough acquainted with it to say just what are its weakest points. The point on which the writer found the most complaint was a noticeable tendency to heat, especially in case of any carelessness in regulating the quality or quantity of its oil supply. "An ounce of prevention is worth a pound of cure," is a saying that is even more applicable to this pump than any of the others in avoiding trouble from heat.

Of course, the main pistons and their packing rings in this pump will wear the same as in any pump, and after a long period of service the cylinders will become worn out of true and require reboring.

This state of affairs will manifest itself by a blow at the steam exhaust or a noticeable reduction in the efficiency of the pump without any apparent reduction in speed of stroke. There will also be an aggravation of the tendency to heat, due to a part of the air being churned back

and forth by the packing rings. Let us repeat here what was intimated before in treating of the other pumps, that nothing will cause a pump to heat so badly as leaky packing rings or too much clearance in the air cylinder. If there is practically no air left in the cylinder at the end of each stroke so an entirely new supply may be drawn in each time from the atmosphere, there will be little trouble from heating.

If this pump begins to pound very badly the reversing valves (5 and 6), stems (7 and 8), and plates (20) must be carefully examined to see if they are worn in any part, and new ones should be substituted if necessary. The points where this wear is greatest are the shoulder and button on the stem and the plate itself.

# GOVERNOR.

Before considering the disorders to which the governor is subject, let us say a word about the use for which it was designed. This will assist us very materially in treating any difficult cases.

The necessity which was the mother of the invention of the governor arose from the large number of wheels that were flattened on many different roads as a result of an excessive pressure in the train-pipe. This was the primary cause. Other causes there were of less importance; among them being the need of some device which would prevent, as far as possible, needless wear of the pump and waste of steam.

A governor is a throttle-valve for the pump, operated automatically by the air pressure. There are many different styles in use, but they all operate on the same general principle.

There is a steam-valve in one end which controls the flow of steam to the pump, and is attached to a piston in such a manner as to be operated by the piston in shutting off the steam to stop the pump. The other part of the governor is a kind of a safety-valve which controls the opening from the source of air supply to the piston which operates the steam-valve. This safety-valve is held shut by a spring under adjustable tension, and

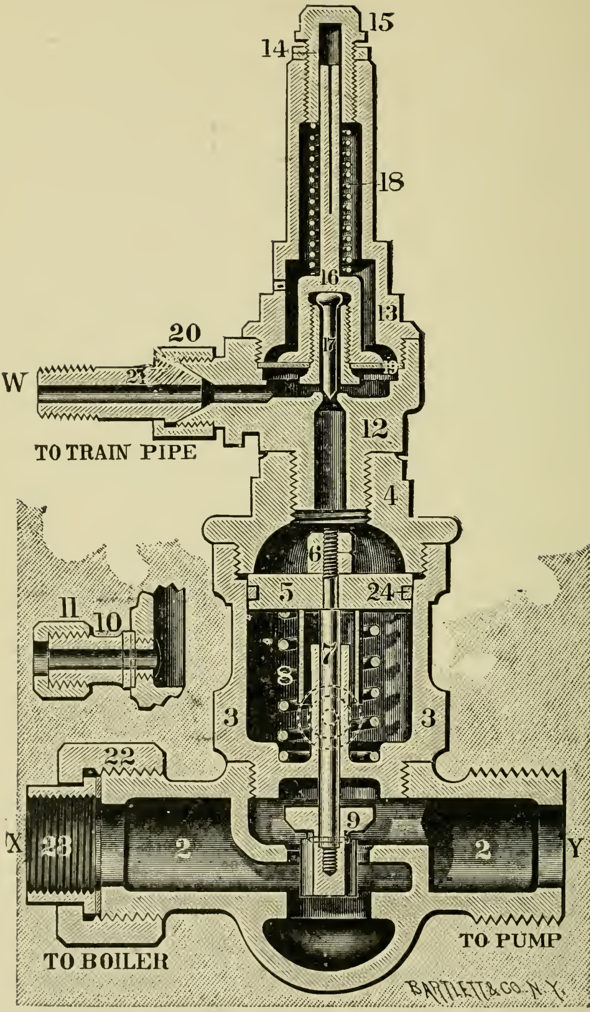



 PLATE 5. WESTINGHOUSE OLD STYLE PLATE D 9.

when the air pressure accumulates to a sufficient degree to open the safety-valve, the pressure which escapes passes to the piston cavity, and forces the steam-valve shut, stopping the pump. When the air pressure is reduced the safety-valve closes again, and the air which is holding the piston against the steam valve, leaks by till the valve opens and allows the pump to start again.

### DIAGNOSIS.

The first thing to notice about a governor that is not working properly is the air connection. Find out whether it is made to the train-pipe, main drum, or some other place, as this has a great deal to do with its action. It cannot be expected that the governor will stop the pump when the main drum has accumulated 90 pounds pressure unless the air supply to the governor comes from the drum, and no governor can be blamed for irregularities in the train-pipe pressure unless it receives its supply of air from the train-pipe.

### PARTS MOST LIABLE TO GET OUT OF ORDER.

Referring now to the governor shown in Plate 5, which in general construction is a representative of all three shown, let us consider which parts are most liable to become deranged. First of all, the diaphragm valve (17), with its co-acting parts, is the most sensitive, and should receive the most careful attention. The accumulation of dirt around the small seat of this valve is the only trouble with many governors reported defective.

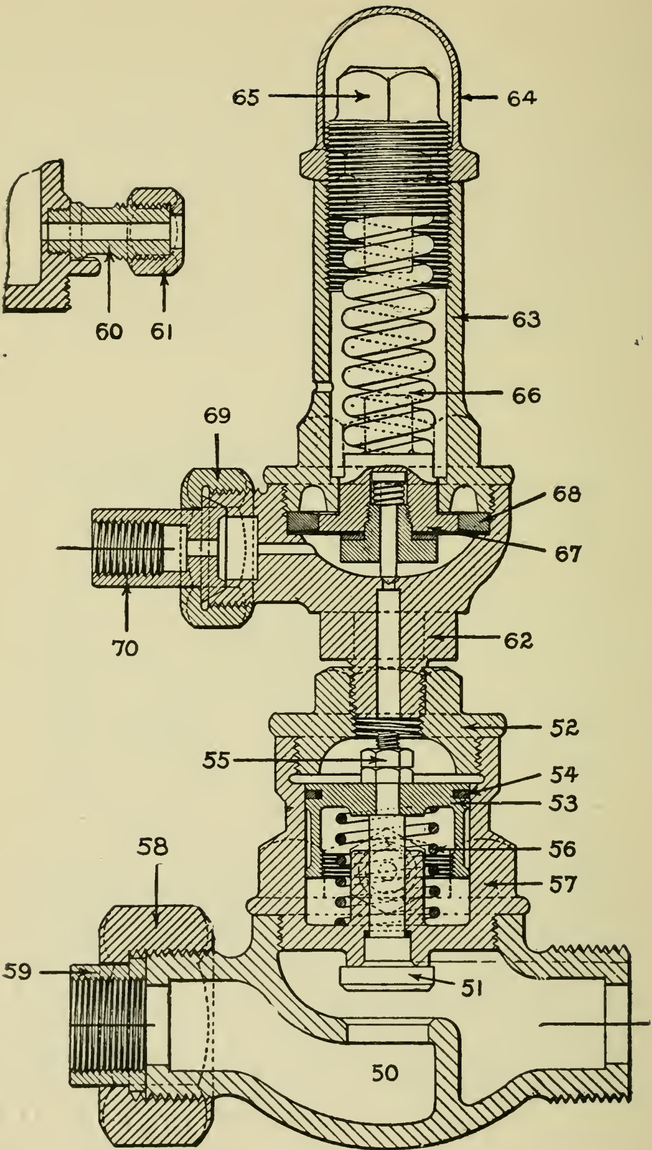





PLATE 6. WESTINGHOUSE IMPROVED.

### CARRIES TOO MUCH OR TOO LITTLE AIR.

This may produce either of two opposite effects. It may cause the pump to stop at too low a pressure from holding the valve open, so that the air constantly leaks through, or, if the dirt be gummy or sticky, it may accumulate in such a way as to gradually decrease the opening or lift so that the pump will accumulate too much pressure.

### SLOW IN LETTING THE PUMP START.

Sometimes it has the effect of so reducing the sensitiveness of the governor that a reduction of several pounds may be necessary in the air pressure before the pump will be permitted to go to work again. That it is necessary for a governor to work very sensitively is something that is not understood by many air-brakemen, and yet if a governor does not meet this requirement it will give a great deal of trouble in service from sticking of the brakes or loss of excess pressure where the connection is made to the train-pipe.

### RELATION OF GOVERNOR TO EXCESS PRESSURE.

Many men may want to know what the governor has to do with the excess pressure when the connection is made to the train-pipe and not to the drum. Let us consider a common difficulty in service that will help to make this point clear. Frequently, on the road, when the engineer's valve handle is in the running position and the main drum has 90 pounds and the train-pipe 70 pounds pressure, with the pump stopped, the excess pressure will gradually begin to disappear, the red pointer or main drum pressure sometimes falling a little below the black

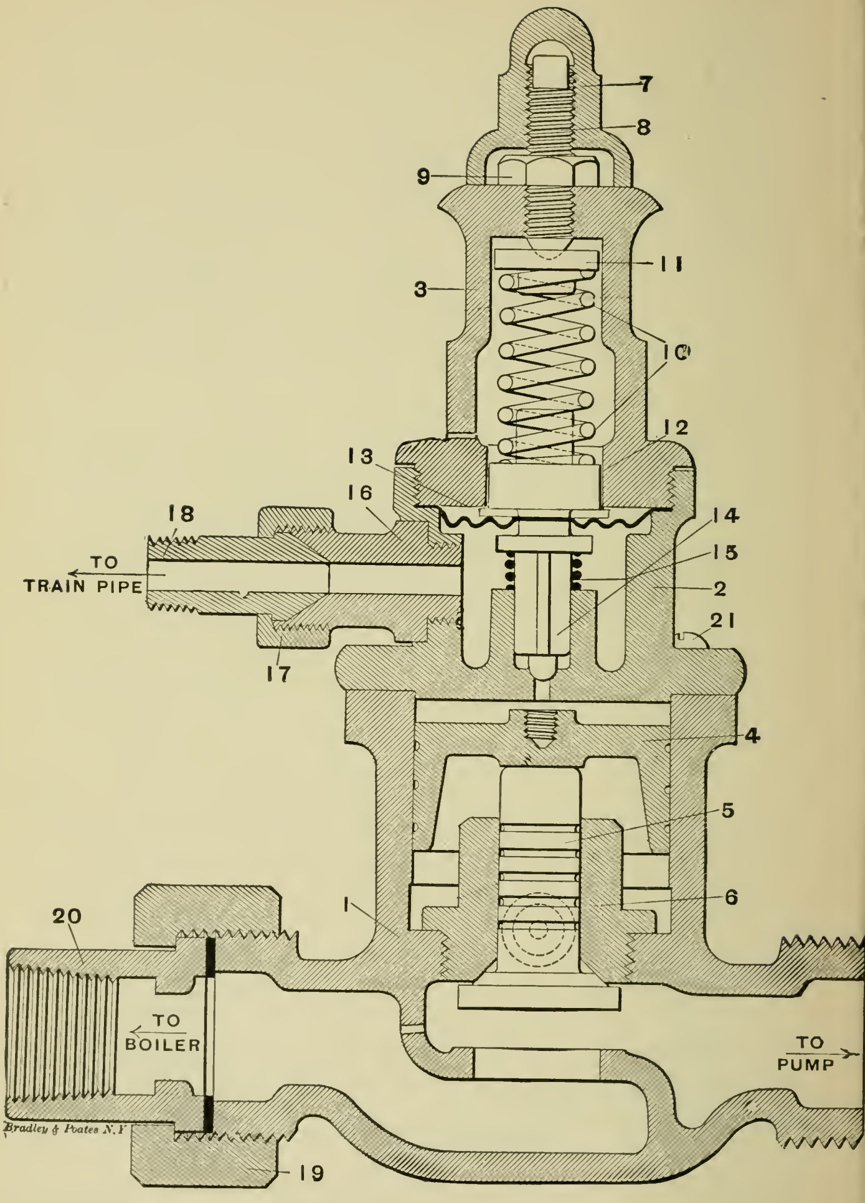



PLATE 7. NEW YORK GOVERNOR.

one, till the black one begins to fall with it and the brakes set and drag before the pump can get to work and release them. Of course, it may be said that this trouble is due to leakage; and so it is; but the fact remains, that if the governor were in proper shape it would not occur. Some leakage is unavoidable, such as will be lost through bell ringers, sanding apparatus or other auxiliary devices attached to the air-brake system. The case described just above is most liable to occur on trains where there is little leak in the train-pipe, for a heavy leak in the train-pipe would not permit the pump to stop.

### BUCKLING OF DIAPHRAGM.

Another part liable to get out of order is the soft metal diaphragm (19), which sometimes gets loose at the edges, or "buckles." In the experience of the writer, however, this is not of very frequent occurrence. Altering the length of the valve (17) is a very bad thing to do, as it may get so short as not to seat at all, causing the governor to throttle the pump all the time at about 40 pounds. It is better not to take the valve (17) out at all if it can be avoided, as a leak out of the vent-hole in the upper casing will be very apt to result if the nut that holds this valve does not screw back to exactly the same position.

### BUZZING.

Splitting the stem 16 was done to prevent the buzzing or rattling noise the first governors made, and this practice is still followed, though it was afterward found that the cause of the noise was the lack of a packing ring in the piston (5), which was omitted in the earlier construc-

tion. The author thinks this split stem interferes a little with the sensitiveness of the governor if it is spread at the top, and would recommend that all such be straightened and trued, so as not to bind in the nut.

### REFUSES TO STOP THE PUMP.

If the governor is entirely inoperative—that is, does not stop the pump at all—the trouble may be found to be due to one of several different causes. Either the small vent hole in the side of the cap (13) may be stopped up, permitting the accumulation of back pressure above the diaphragm; the exhaust stud (10) may be stopped; the piston (5) may be stuck in some manner, or the brass backing above the diaphragm (19) may be too thick, preventing the valve from raising.

### FREEZING OF EXHAUST.

Cases are not infrequent, where in very cold weather, the exhaust-pipe leading down from the stud (10) has become frozen solid, the train-pipe pressure accumulating to over 90 pounds before the engineer discovered that the governor had ceased to act. This is a difficulty very hard to locate, as it thaws out when the engine is brought into the house, and then, of course, the governor works all right again.

### LOCATION OF GAUGES.

Many gauges are placed in such a position that they cannot be seen at night, and in such cases failure of the governor may slide many wheels before the engineer finds out that his governor has stopped working. No engineer

can take time to get up every few minutes and light a match to see how his air pressure stands. He has other things to do.

BINDING.

As to the lower part of the governor, see that the rod (7) and piston (5) fit well and still work freely, and do not have the packing ring (24) too tight a fit, else the governor will not open promptly.

## Mason Regulator.

The Mason regulator is shown in Plate 7 (*a*). As its principle of operation is quite different from those previously described, we treat of it here under a separate head. The general distinction may be stated to be that in this one the operative fluid pressure (that which moves the piston to stop the pump) is *steam*, brought into play, of course, by pressure from the train-pipe, while in the others the train-pipe pressure itself acts directly to close the main valve. In examining one of these governors out of order, however, we have to begin with the same general diagnosis as was used in the other cases. That is, note whether the difficulty is too *much* or too *little* air pressure, or whether the pump is stopped entirely.

TOO MUCH AIR.

If our case is one in which the governor refuses to stop the pump when the desired pressure has been reached, we can conclude that something is holding the main valve (21) open. This may be dirt under the seat of this valve, boiler scale perhaps, or what is much more probable, it may be steam pressure under the piston (19). If this be

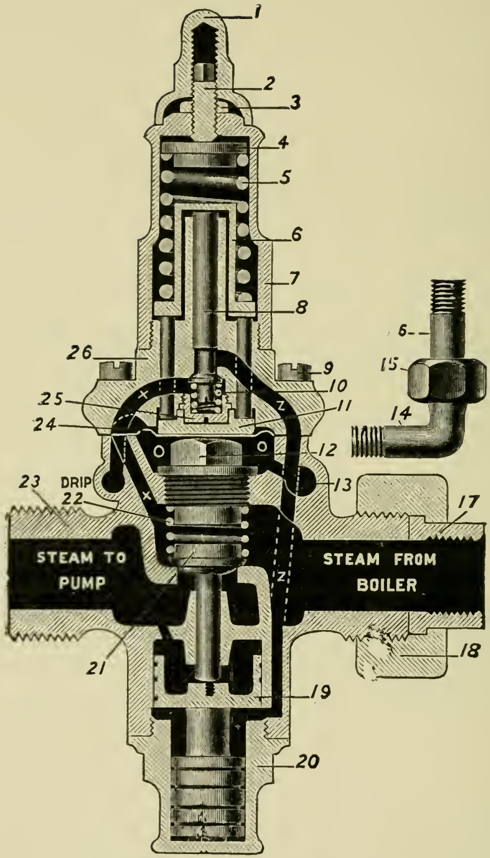





PLATE 7 A MASON REGULATOR.

the case, it is very evident that the auxiliary valve (8) is not seating properly, for if it did no steam could then get under the piston (19).

This will generally be found to be the cause of this trouble, for this valve, being smaller and more delicate than the main valve (21), will naturally be more sensitive to dirt and need more frequent attention. To get the valve (8) out proceed as follows:

Shut off both steam and air. Remove the cap (1) and unscrew the adjoining screw(2) until all tension is removed from the spring (5). Take out the screws (9) and remove the bonnet and diaphragm; when, by unscrewing the nut (25) and lifting out the small spring, the auxiliary valve (8) may be reached. This valve should work with considerable freedom, and have a good tight seat.

### TOO LITTLE AIR—PUMP STOPPED.

If the pump stops, and the regulator will not let it go to work again, it is very clear that for some reason or other the main valve (21) has failed to open, and some defect must be holding it, or rather the piston (19) which operates it, from moving. The piston is intended to be moved by steam pressure through an opening controlled by the auxiliary valve (8), and it is possible this valve is stuck shut, or, for some reason, refuses to let the steam pass. Corrosion, from standing long without use, might cause such trouble. Another thing which might interfere with the opening of the main valve (19) would be a binding of the piston (19) or its dash-pot extension. Sometimes variation in expansion from the heat of the steam will cause such trouble. Of course, the proper remedy

for this is to take the piston out and reduce the size of it a very little, preferably with the use of emery cloth, so that it may work with perfect freedom when put back into place.

# MAIN DRUM.

The main drum is a very important although simple part of the apparatus, and one which seldom receives the consideration that it merits. It performs two separate and distinct uses. First, it acts as a storage reservoir for air, to be used in releasing brakes or charging the train, and second, it is of great use as a drain-cup to free the air from water, oil or other foreign substances. Particular care should be taken to have it located properly on the engine and to have the pipe connections properly arranged.

### LOCATION.

In order to act to the best advantage as a drain-cup it should be placed as low as possible, the best place where there is room enough, being under the forward end of the boiler. Sometimes it will fit better under the deck of the cab. Always avoid putting it on the tender, as such a location generally necessitates its being pretty high, and also requires the use of a hose connection in the pipe from the pump, leading from the engine to the tender, and this will frequently rot out on account of the water and oil which come directly from the pump, rendering the brake entirely useless in case of a rupture. As to the storage capacity of the main drum, there is only one rule. Make it as large as possible. The larger the better. If there is not room anywhere for one big one, put two little ones

on and connect them with a large pipe. Great care should be taken to see that they can be both readily and *completely* drained, and this should be done as often as possible. Twice a week is not too often by any means.

### IMPORTANCE OF DRAINAGE.

Remember, there are two important reasons for this: First, the water, if allowed to accumulate in the drum, will get into the triple-valves and interfere with their action, freezing them up in cold weather; and second, the more water there is in the drum, the less room there is for air, and, consequently, the less pressure there will be available to release the brakes or recharge the train.

More than one runaway on a grade has been caused by water in the main drum, there not being sufficient storage room for air to properly recharge the train after the brakes are released. There have been many cases of brakes sticking where there was no trouble at all with the apparatus itself, but simply too much water in the main drum.

It is hardly necessary to state that when a disease is as easy to cure or prevent as this one, there is very little excuse for its existence. Never stop to go through any brain-racking argument as to whether there *is* water in the drum, but go right to work and let it out. There is SOME water in *every* drum, and even if it is only a few drops, it never hurts to let it out. A few words as to where so much water comes from may not be amiss here. It is not, as many suppose, entirely the result of leakage past the piston-rod from the steam cylinder. In fact, comparatively very little of it is from that source. It is simply an unavoidable consequence of the compression of air.

### SOURCE OF THE WATER.

All air contains moisture in suspension, and of course the more cubic feet of air we compress into one cubic foot the more moisture there will be in that one cubic foot, until, finally, it becomes so saturated that it will not absorb any more, and what surplus there may be is precipitated and collects in the bottom of the receptacle.

The pipe connections from the pump and engineer's valve should both be made near the top or highest side of the drum, so that any water that may collect in the bottom may not interfere with the flow of air through them. This is *especially* true of the pipe leading from the drum to the engineer's valve.

### LEAKAGE.

Besides water, about the only other trouble to which the drum is subject is leakage. To test this, the engineer's valve handle should be placed on the lap, and the pump stopped, when a falling of the red pointer on the gauge will be noticed almost immediately in case there is any leak.

These leaks are not often in the drum itself, but in the pipe connections from the drum to the pump or engineer's valve, frequently at the union next to the drum. A good deal of trouble will be experienced with leakage at this point if the drum or pipes are insecurely fastened in place, as the constant shaking will loosen the joints.

Many engineers seem to think that a leak in the drum is not of much consequence. This is a very grave mistake. It often causes sticking of brakes after the governor has stopped the pump. Even a small one should be properly attended to just as soon as possible.

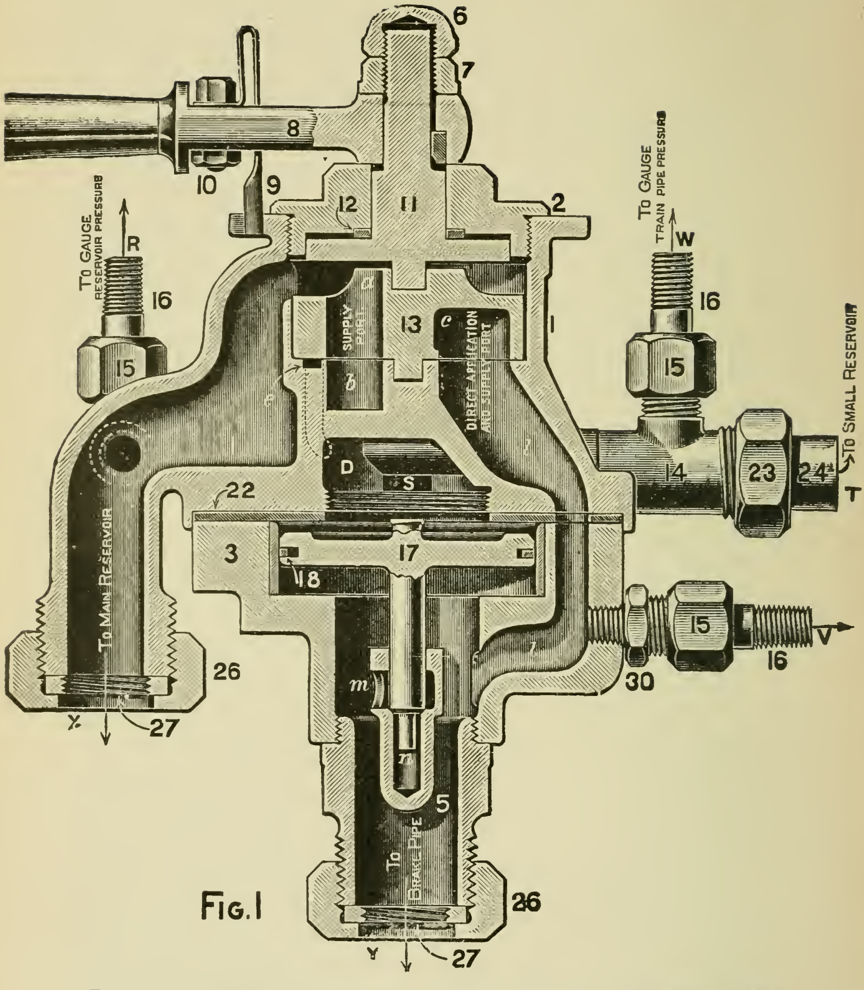



PLATE 8. WESTINGHOUSE EQUALIZING DISCHARGE VALVE. (PATTERN OF 1890.)

# ENGINEERS' BRAKE-VALVE.

Before going into details as to the difficulties that arise in the use of the engineers' brake-valve, it will not be inappropriate to say a few words as to the different styles that have been and are now in most general use.

### THREE-WAY COCK.

The first form used with the automatic brake was an ordinary three-way cock, the ones that had been used for straight air being made to do service by using the handle in the reverse positions.. This cock was simply a brass valve with three connections, one from the main drum, one to the train-pipe, and one an exhaust to the atmosphere. In one position of the handle, called the release position, there was communication between the main drum and the train-pipe, the exhaust being closed ; in another position of the handle, called the application position, the exhaust from the train-pipe was open, the communication from the drum being shut; while the third position was midway between these two, and as it blanked all the ports, it was termed the "lap."

These three positions form the foundation for nearly all the engineers' valves since designed to operate automatic compressed air-brakes.

The main difficulty with the old three-way cock was that it had such a large port opening as to make too sudden a reduction when a service stop was desired. Another trouble was, that unless closed with very great care the

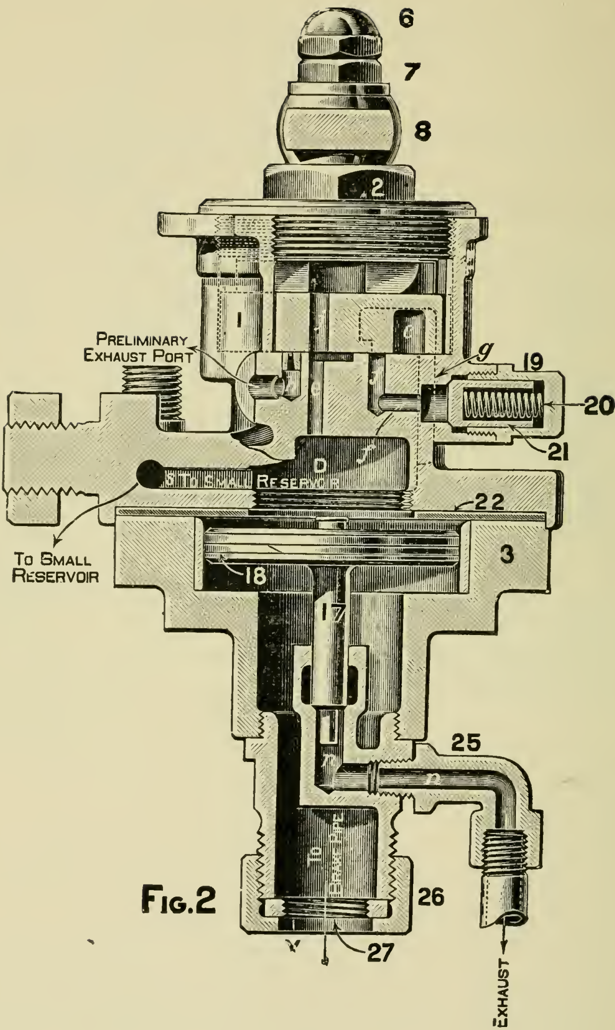

6
7
8
2
Preliminary Exhaust Port
g
19
20
21
D
f
To Small Reservoir
22
To Small Reservoir
3
18
17
25
26
27
Exhaust

Fig. 2

Plate 9.

stoppage of the opening was very apt to release the head brakes from the recoil of the train-pipe pressure.

Besides this there was no provision in the original three-way cock for storing any excess pressure in the main drum, and this made it difficult at times to properly release the brakes.

This old valve, being in the shape of a plug-cock, was very liable to leak after a short period of service, as grit and dirt which got into the valves would cut grooves around the bearing. If it was screwed together too tightly it was very hard to move, and if it was left loose it was constantly leaking.

### BRASS ENGINEER'S VALVE.

The next valve to come into general use was a small brass valve with a rotary disk as the main operative part. This had an excess pressure valve and a spring device for cushioning the valve, which cut off the exhaust of air in applications of the brakes. This valve had several springs in it which gave considerable trouble from weakening, and one which bothered considerably because of the corrosion making it brittle and stiff. The one which weakened the most was that which was placed just above the main or rotary valve, or more accurately, just within the head of the handle, and the result of this was to cause leakage in the train-pipe in the running position or on "lap." The excess pressure valve was the one which bothered by getting corroded, and this was because this was placed right in the center of the main body of the valve, and arranged in such a way as to be exposed to all the oil and water.

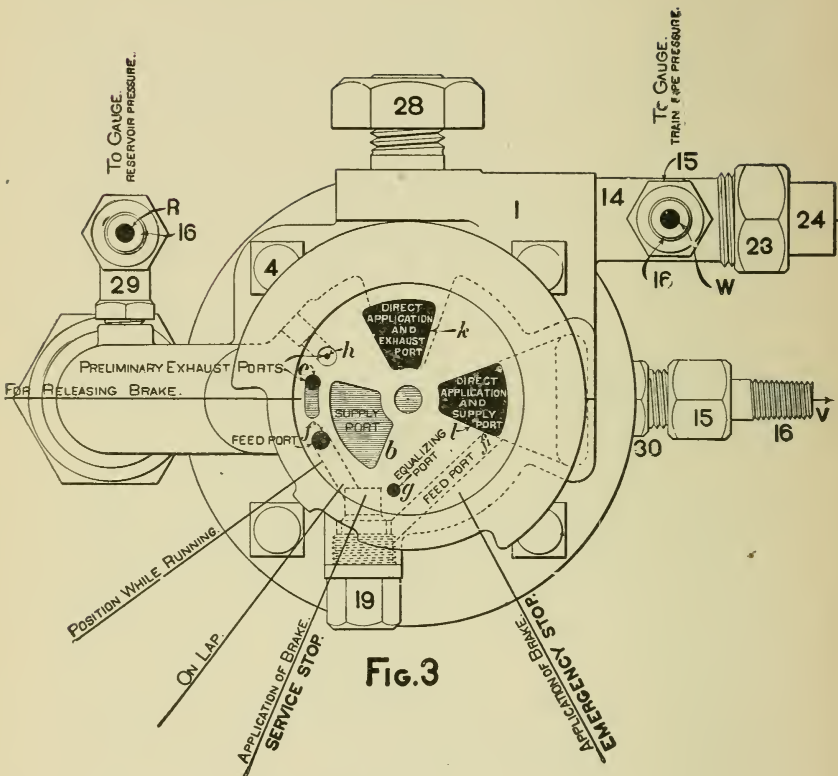



Fig. 3

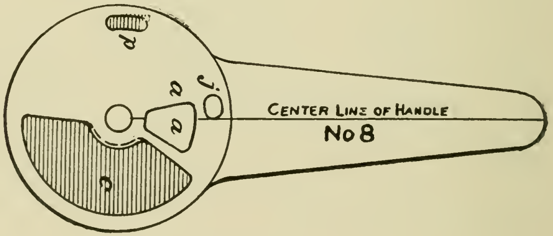



Fig. 4



Plate 10.

Strange as it may seem, this small valve, the one requiring cleaning and repairs most frequently, was placed in the position most difficult to reach. To get it out required the taking apart of the whole valve.

### EQUALIZING DISCHARGE-VALVE.

Following the second one came the equalizing discharge-valve, and this we have shown on plates 8, 9 and 10, as it was first put into most general use. The modified form now supplied by Westinghouse, of which we shall treat later, is, in most respects, the same in principle, the main difference being in the use of the feed-valve instead of an excess pressure valve.

The parts of this valve most frequently requiring attention are, the rotary-valve (13), excess pressure valve (21), and equalizing piston (17). These should all be taken out frequently and cleaned.

### OILING PARTS.

The rotary and piston should be carefully oiled before replacing, some oil which will not gum being the best to use. In selecting an oil it must be remembered that when the valve stands near the boiler head it is subject to considerable heat, and any oil which dries rapidly is not suitable under such circumstances. The piston (17) seldom gives much trouble unless too much oil is being used in the air cylinder to the pump, in which case gum will collect around the valve-seat and reduce the size of the opening.

### BLOW FROM EXHAUST.

A constant blow out of the exhaust opening indicates dirt on the seat of this discharge-valve, and if it does not

blow out on a heavy reduction in the train-pipe, will necessitate the removal and cleaning of the piston.

An intermittent blow when the handle is on the lap indicates a leak somewhere around the cavity above piston (17), or the pipe connections to the small reservoir or train-pipe gauge.

A leak around any of these connections acts the same as a slight reduction in service stop position, causing the graduating piston to raise and open the train-pipe exhaust until train-pipe pressure is reduced below that in the cavity, when the valve will seat again.

A very small leak around any of the connections mentioned will cause quite a blow when the valve handle is on the "lap" because of the limited quantity of air contained in the small cavity and equalizing reservoir, and the fact that when the handle is on the "lap" all supply to this part is cut off. In the running position this blow will not show, because the equalizing port (*e*) from the train-pipe to the cavity (*D*) is open, so that the train-pipe loses pressure as rapidly as the cavity.

### LEAKS AROUND CAVITY.

Leaks from this cavity are very apt to occur around the joint of the gasket (22) between the two parts of the valve, especially if the valve stands very near to the boiler-head, as the heat dries the leather and makes it contract. Generally this can be remedied by tightening up the four nuts that hold the valve together, although sometimes it is necessary to put in a new gasket.

To become convinced of the importance of keeping all joints around this valve and the gauges tight, it is only

necessary to experiment on a valve by *making* a leak (loosening the union connection to the small reservoir, for instance), and, with the handle on the "lap," examining the blow that will come out of the train-pipe exhaust.

This blow will, of course, be much heavier on a long train than a short one.

### CLEANING ROTARY.

As stated above, it is necessary to frequently take out the rotary-valve and clean it, and to do this it is necessary to let all the air out of the main drum, as that pressure bears against the top of the rotary-valve all the time. There are two convenient ways of doing this. One is to remove the valve handle so that the spring will not interfere, and then turn the handle upside down on the square and move it to a position about opposite the "lap," or, if there is not room for the handle to clear, use a wrench. Another is to leave the valve handle in the release position and go to the back of the tender and open the hose-cock.

### DEFECTIVE HANDLE SPRING.

There is one point about the engineer's valve which is very frequently neglected, notwithstanding it is of great importance. It is the handle spring No. 9 which fixes the positions of the valve.

From violently striking the notch in release or emergency position this often gets bent or works loose, so that when apparently in running position, the ports may actually be lapped. When left in this position for some time the train-pipe pressure may reduce to such a degree as to be of little account for an emergency stop, and a serious

wreck may be the result. In fact, a number of serious wrecks have been attributed to this very cause, cases in which, as the papers say, "the air-brakes failed to work," simply because there was not sufficient air in the pipes to work them. The author has seen engineer's valves in operation on which the spring was broken or missing, and the engineer had to guess when his handle was in the running position. Of course, in examining the spring the quadrant should also be examined to see that the notches are sufficiently accurate and abrupt, and no one should alter these notches because the "excess pressure does not work right" unless perfectly sure that the ports do not register correctly.

### EXCESS PRESSURE.

Now that we have touched on the excess pressure valve, let us say a few words more about it, and then consider the change that has been made in the latest valve by the substitution of the feed-valve in its place. The excess pressure valve shown on Plate 9 (No. 21) requires frequent removal and cleaning. If there is too much or too little excess the valve should be taken apart and cleaned, after which it should be put in place and tried before anything further is done, as there may be no other trouble. To get at it most readily leave the handle in the service stop notch, with the train-pipe shut off either under the valve or back of the tender, in case there in no stop-cock in the train-pipe in the cab, when it will not be necessary to bleed the main drum. Twenty pounds is generally recommended as the proper amount of excess pressure to carry, and this is a good average.

The author prefers, however, to vary it according to the service in which the engine is running. In suburban service, where the trains are short, from five to ten pounds is ample, while on long freight trains twenty is not too much. Where frequent stops are made, requiring considerable air, much excess will make it difficult to keep the train-pipe pressure up to the proper point on the valves we are now considering, which do not feed the train-pipe at all until the excess is pumped into the drum.

Under the head of governor, will be found the explanation of the alternate increase and decrease of excess pressure so often noticed after the train-pipe pressure has reached the limit at which the governor is set. *This* difficulty is not due to any defect in the excess pressure valve at all, and it is only a waste of time to take the engineer's valve apart in endeavoring to remedy it.

### TOO RAPID FALL OF GAUGE POINTER IN SERVICE STOPS.

If it is noticed on any valve that the gauge pressure reduces *very* rapidly when the handle is placed in the service stop position, it is a sure indication that there is some obstruction in the connection from the valve to the equalizing reservoir or that the reservoir is nearly full of water. Anything which will tend to decrease the capacity of the air in the cavity above the equalizing piston will produce this effect. To experiment on this, put a blind gasket in the union connection between the valve and little reservoir, when the handle can hardly be moved to the service stop position without losing all the gauge pressure at once.

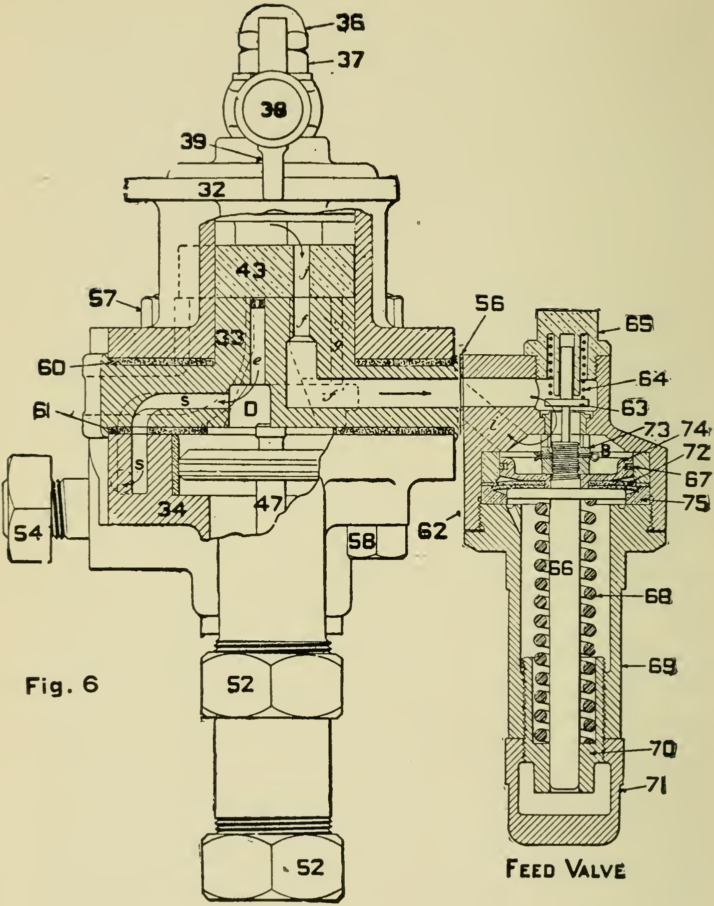



Fig. 6

PLATE 11.

WESTINGHOUSE ENGINEERS' VALVE, WITH FEED VALVE ATTACHMENT. (1893 PATTERN.)

### TOO SLOW REDUCTION OF GAUGE PRESSURE IN SERVICE STOPS.

If the pressure on the gauge reduces too slowly in service stop applications, it is generally an indication that the small equalizing discharge port is partially closed by gum or dirt and should be cleaned out. The same effect would be produced by having too large an equalizing reservoir, and the difficulty would be aggravated in direct proportion as the capacity of this reservoir was increased. The author once saw an engine on which a 12 x 33-inch reservoir had been placed because the small equalizing reservoir had not been sent with the valve. The engineer very justly complained that his brakes were very slow to set, until finally the proper drum was put in place. It should be understood that the discharge-port and little reservoir bear a certain proportion to each other, and any change in either will be pretty sure to result in trouble.

### FEED-VALVE.

The feed valve (Plate 11), which has been substituted for the excess pressure valve in the latest form of the engineer's valve, is nothing more or less than a pressure regulator controlled by the amount of air in the train-pipe. It is generally set at 70 pounds, as this is the standard on most roads. It is controlled by a diaphragm actuated by a spring on one side and the train-pipe pressure on the other, and stays open until the train-pipe has accumulated the limit of pressure, when it closes and allows the excess to be pumped into the main drum.

With this construction the governor, set at 90 pounds,

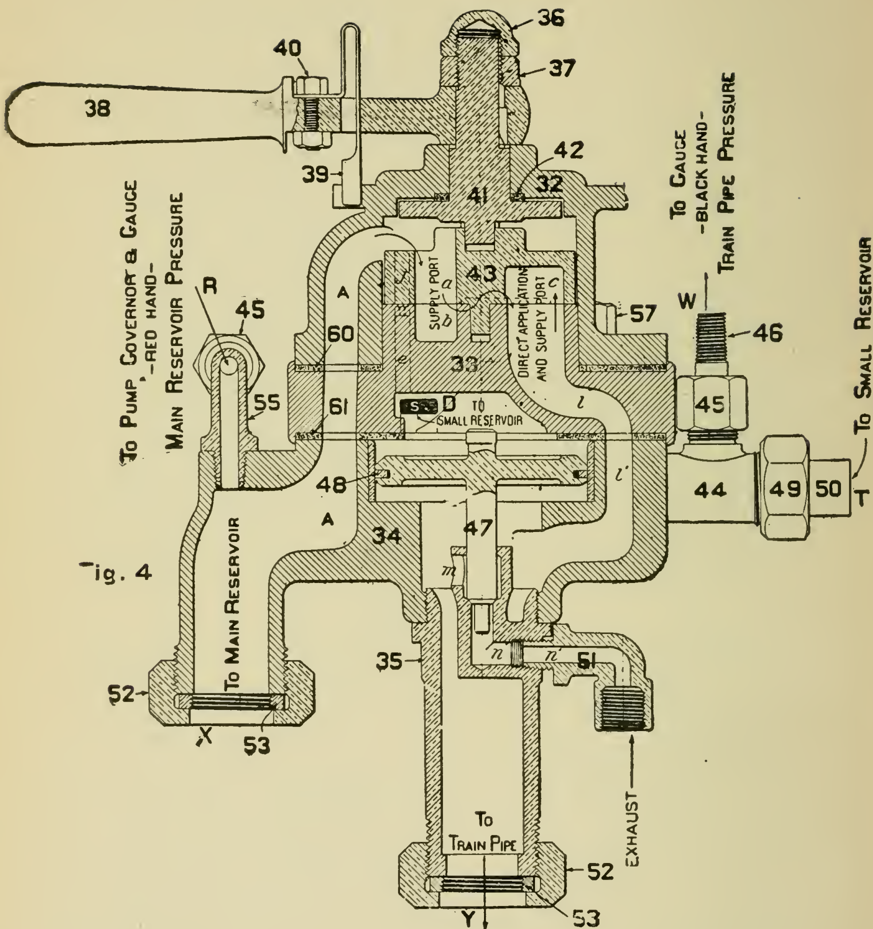



Fig. 4



PLATE 12.

is attached directly to the main reservoir, as the feed-valve prevents the train from accumulating over 70 pounds in the running position.

With the feed-valve it is impossible to have *any* excess pressure until the train has accumulated its 70 pounds, as, up to that time, there is an open passage from the drum to the train-pipe in the running position as well as the release, the only difference being that the port which is uncovered in the running position is smaller than that used in the release.

With a clear understanding of the principle of operation there ought to be very little difficulty in locating any defects that may arise in the operation of the device.

### CARRIES TOO MUCH AIR.

If the train-pipe accumulates more than 70 pounds in the running position it is very evident that air must be passing from the drum into the train, but the conclusion must not hastily be made that this is due to a defect in the feed-valve, for it may be, and not infrequently is, caused by an imperfect gasket between two of the main portions of the body of the valve. This is most apt to occur in gasket (61) just at the point to the right of the passage in which Fig. 61 stands in Plate 12, at which place it will be noticed there is a very narrow bearing.

Leakage by this gasket will be manifested in still another way much more troublesome than a mere increase in the train-pipe pressure.

### SLUGGISH ACTION OF BRAKE IN SERVICE.

It will prevent either partially or entirely the application of the brakes in service position. This is because the

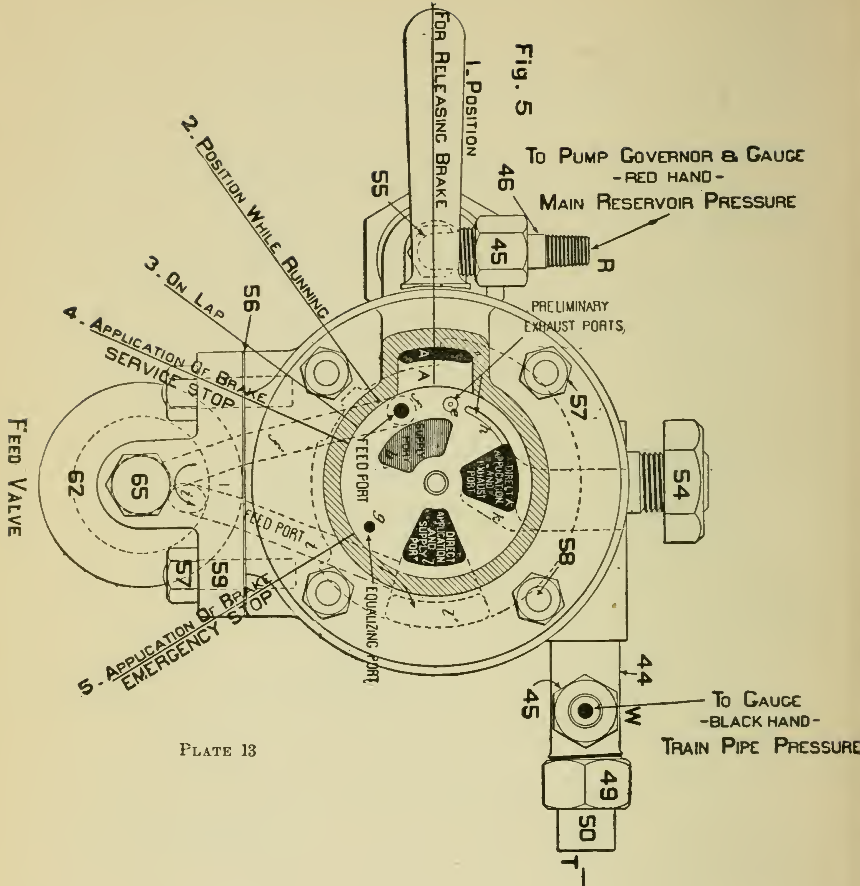
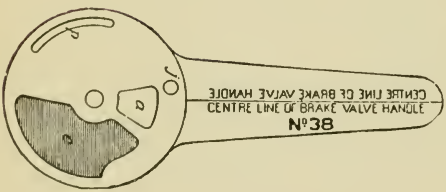



Plate 13



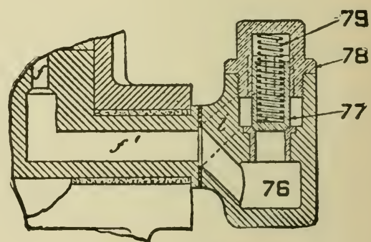




Fig. 8



Plate 14.

pressure in the cavity *D* will not reduce with sufficient rapidity through the small preliminary exhaust port if air is leaking from the main drum into the cavity at the same time.

To go back now to the increase of pressure in the train-pipe.

This may be due to trouble with the feed-valve. It is possible it may not be properly adjusted, or if it is all right in that respect it may be found to seat imperfectly. This may be due to some bend or defect of a similar nature in the small spindle of the valve (63) or possibly merely dirt on the seat of this valve. In a case of this nature it is hard to determine which is the most promising field to investigate first. If in service application the reduction in cavity *D* is found to be slower than it should be, the trouble is probably in the gasket, but if this symptom is not present at all, it is a reasonable supposition that the gasket is all right, and something else must be examined instead.

## BLOW FROM EXHAUST WHEN HANDLE IS PUT TO RUNNING OR RELEASE POSITION.

An excessive blow out of the train-pipe exhaust port on a lone engine or very short train (one or two cars) when the handle is moved to running or release position after applying the brakes, is no cause for alarm unless it be very extreme, as it is simply due to the fact that the train-pipe fills more quickly than the cavity *D* because the ports are larger, and until the pressure on top of the equalizing piston becomes greater than that beneath it,

such a blow must be the natural result. This blow will stop more quickly if the handle be thrown immediately to full release position in letting off the brakes than if merely moved to running position, as, in the former case, the cavity (*D*) then has the benefit of an additional port (*e*) through which it may fill, while the release opening is not as much greater in proportion. If the piston refuses to close the exhaust in a reasonable time it should be taken out and thoroughly cleaned.

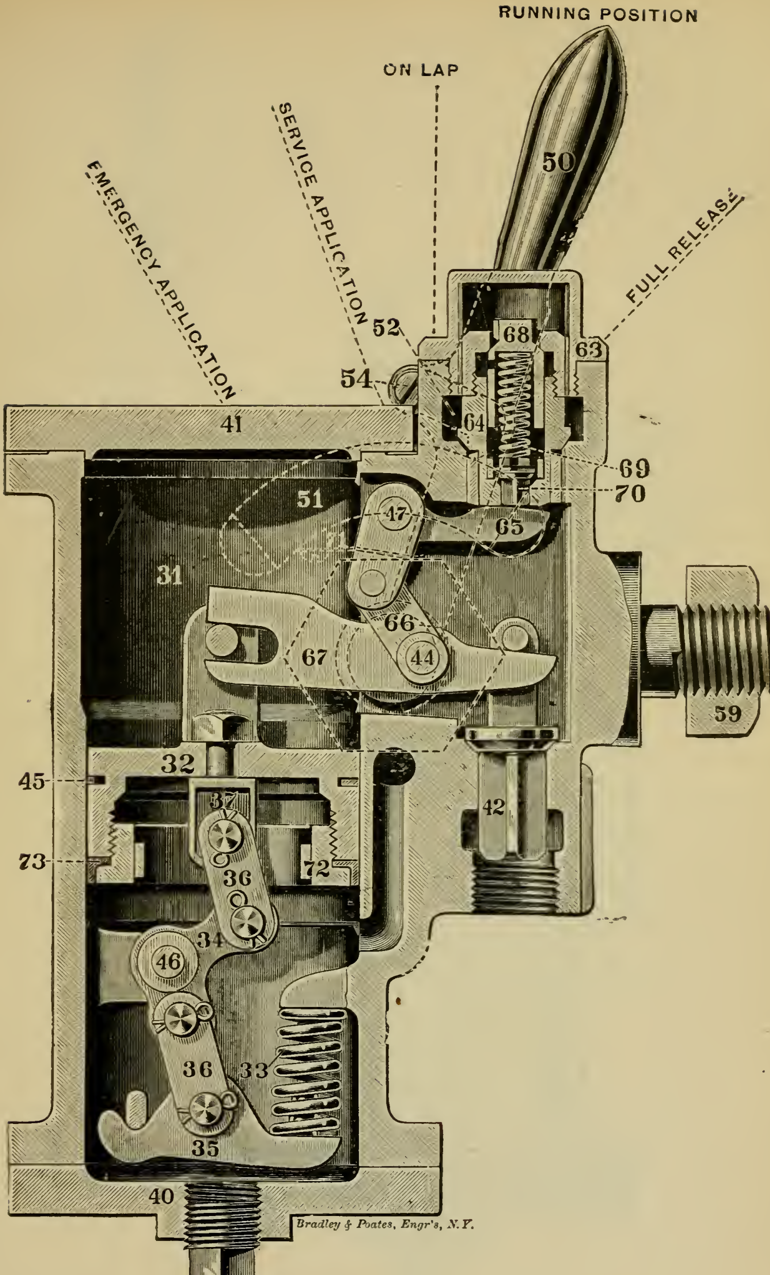





PLATE 15. NEW YORK ENGINEERS' VALVE.

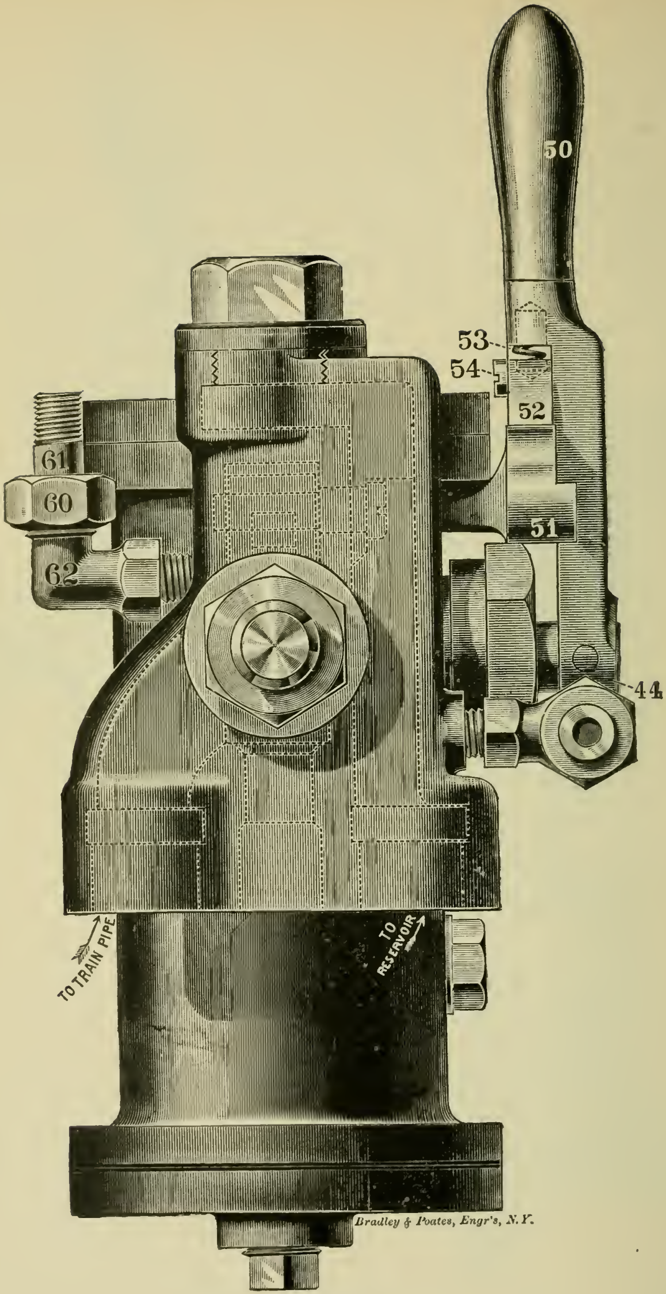

50
53
54
52
51
44
61
60
62
TO TRAIN PIPE
TO RESERVOIR
Bradley & Poates, Engr's, N. Y.



PLATE 16.

## New York Engineers' Valve—Plates 15 and 16.

This valve, as well as the two of which we have previously treated, has the three principal positions of the old three-way cock; ''release,'' for letting the air from the drum back into the train; ''application'' for shutting off the drum and exhausting the air from the train to the atmosphere; and ''lap,'' which closes all communication either way.

### BLOW FROM EXHAUST.

If there is a blow out of the exhaust when the handle is in the release position, or on ''lap,'' valve 42 is the offending part, and must be examined to ascertain whether it seats properly and if the seat is tight. If the pressure in the train-pipe constantly increases while the handle stands on ''lap,'' the connections controlling communication from the drum to the train must be investigated. These are the piston(32)and the valves(64 and 70). The piston is balanced between drum pressure below and train-pipe pressure above, and if the packing rings are not perfectly tight, the pressure in the train with the handle on the ''lap'' will soon show a gain on the gauge when the engine has no cars attached, or in other words, only a short pipe connected. This leakage can be reduced to a minimum by keeping the leather (73) soft and pliable.

### RELEASE OF BRAKES.

Releasing of brakes on the lone engine will be apt to be one of the results of any leakage from the drum into the train, and an examination of the engineer's valve should be made before blame is laid on the triple.

In case of failure of the exhaust from the train to open fully when the handle is put to the emergency position, attention should be given immediately to the spring (33), as a weakening, displacement or breaking of this spring would cause such defective action.

# TRAIN-PIPE.

In speaking of the train-pipe we include all the piping which serves to carry the air from the engineer's valve to the triple-valve throughout the train. *Not* the pipe that carries the air from the triple-valve to the reservoir; as that must properly be regarded as a part of the reservoir. Of course, the hose connections form a part of the train-pipe, as do also the branch pipes leading from the train-pipe to the triple-valves, and on passenger trains the small length of pipe leading to the conductor's valve.

The two great difficulties that arise in the train-pipe are *leakage* and *stoppage*, either of which, but the latter particularly, may be productive of the most serious consequences.

## Leakage.

Leakage may most readily be detected by a continued falling of the black pointer on the gauge when the engineer's valve is placed on the lap, and the rapidity of the reduction will show the extent of the leak.

A very heavy leak will make it difficult, or, in some cases impossible, to maintain sufficient pressure in the train to properly operate the brakes, while a slight leak will sometimes cause a sticking of the brakes, though serious trouble from this cause may be prevented on the

road if the pump be in good condition and the brakes carefully handled, as the constant feeding of pressure back from the engine will overcome the loss. Slight leakage on trains running on mountain grades is more serious, because it results in a constant increase of the braking force when it is not wanted.

### LOCATING LEAKS.

If the engine gauge shows a leak in the train-pipe a careful examination of the following points should be made, as they are the places where it is most likely to occur: Hose couplings, hose, pipe unions under the tender, conductor's valves, and the T at which the conductor's valve branch pipe is connected to the main pipe. A bleeding cock left open on any auxiliary reservoir or a triple-valve blowing from the exhaust will also show as a leak in the train-pipe (that is, by a reduction or falling of the black pointer on the gauge). These cases, however, are very easy to find, because they make a very decided and audible blow at one point.

The T connection, where the conductor's valve branch pipe is connected to the main train-pipe, is particularly mentioned because that is a joint frequently broken by pulling cars apart *without uncoupling the hose.*

### LEAKAGE IN COUPLINGS.

Perhaps the most frequent cause of leakage is to be found in the hose couplings, generally from some defect in the rubber packing ring. A leak at this point should be treated as follows: First uncouple the hose, examine the packing rubber, straighten it if it seems bent or

twisted, and couple up again. If this does not help, and there is no time to replace the hose or packing rubber, take a little nail or wooden wedge and drive it in between the lugs on the coupling in such a way as to force the packing rubbers closer together in the position indicated at 2 in Plate 16 A. A very bad leak may sometimes be entirely stopped in this way. Never strike the lugs on the coupling so as to make it go together more tightly, as this makes it difficult to couple to a coupling which has a new rubber in it, and also increases the liability of rupturing the hose in case the train pulls apart.

### BURST HOSE.

About the only remedy for hose which are burst or leaking is to replace them with good ones. If no extra ones are to be had one can be taken off from a car near the rear of the train, say the last hose on the last car.

### LEAKS UNDER THE TENDER.

The pipe unions under the tender are a frequent cause of leakage, probably because of the conditions surrounding them. Engineers should be very careful to thoroughly examine the equipment on their engines before condemning the train crew for not stopping leaks which may be bothering them. It may be nothing more than a rotten gasket in one of the unions or a loosening of the nut because the pipe has been insecurely fastened and rattles. Too much emphasis cannot be put upon the desirability of having all air-brake pipes very securely and firmly fixed in place. This will prevent a great deal of trouble.

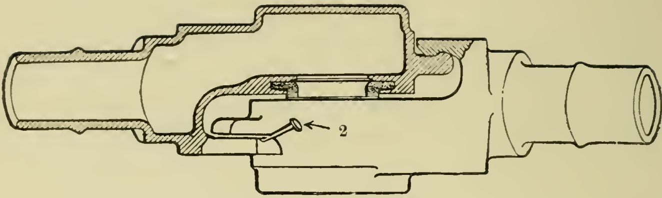



PLATE 16 A.

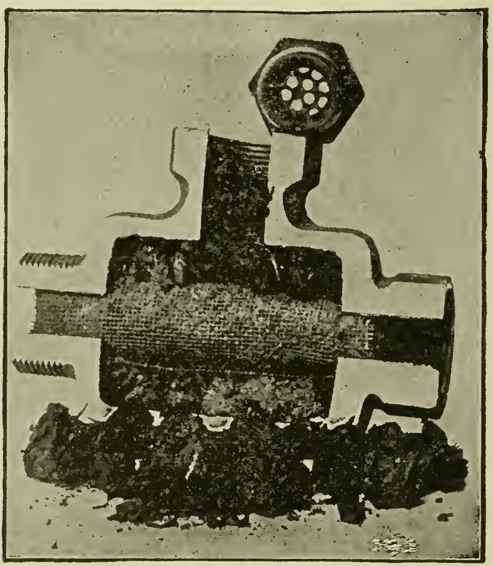


PLATE 16 B.

LEAKAGE IN CONDUCTOR'S VALVES.

Conductor's valves sometimes get to leaking because of dirt lodging in them. Sometimes (and always with the new style) they do not close after having been opened, and although the blow from such a one be heavy it may be hard to find, because the location of the valve in the closet renders it rather inaccessible.

### Stoppage, i. e. Obstruction.

Now we come to the consideration of the second part under this head—stoppage. By this we refer to any obstruction which interferes with the passage of air through the pipe. This difficulty is always manifested by a refusal of the brakes to set or release properly *back of a certain point* in the train, while all those forward of that point operate satisfactorily. Sometimes the stoppage is of such a nature as to allow the air to pass freely through the pipe in one direction but not in the other, the obstruction closing the pipe just like a valve.

It will be very readily seen that this is a very dangerous disease and may result in the death of the patient (total failure of the brakes at a critical time), if it is not very promptly treated and cured.

Of course the closing of a hose-cock somewhere in the train is the most frequent form of this trouble, and great care must be taken at all times to see that this does not occur, or if it does happen, to have it immediately located and remedied. Hose-cocks will sometimes close while running if they stand in such a way as to strike against one of the timbers above the handle.

## TESTING BRAKES.

The engineer can make a very close approximate test of the number of cars cut in from the engine back while he is running as well as when the train is at rest, without in any way interfering with the speed or momentum of his train, by simply moving his engineer's valve handle from the running to the release position after his main drum has accumulated 20 pounds of excess pressure (red pointer 20 pounds higher than the black one), and carefully noting the number of pounds that the red pointer falls during the first couple of seconds. For ten average freight cars it will fall about 10 pounds. For twenty cars or over it will fall fall from 15 to 18 pounds. If the train is cut out one or two cars back of the engine the reduction will be but a couple of pounds. This result will, of course, vary slightly with leakage, the size of the drum and the length of the cars, but a little practice will enable anyone to make a very close guess. If the obstruction in the pipe is of such a nature that it permits the passage of air in one direction but not in the other, it is apt to be still more dangerous. This has been known to occur through a curling up of the inside lining of the hose, the rubber rolling up into a ball, and, just like a valve, opening one way and closing the other. It might also be caused by the cylindrical screen in the car drain-cup collapsing or clogging up with dirt. Plate 16B, taken from the *Railway Age,* shows one that was in the possession of Mr. G. W. Rhodes. It is a fair sample of many that are now in service.

Cases are also recorded where ice has been formed in the coupling or hose sufficient to obstruct the passage. This often results from allowing the hose to hang down and drag through the snow, and afterward coupling it without examination.

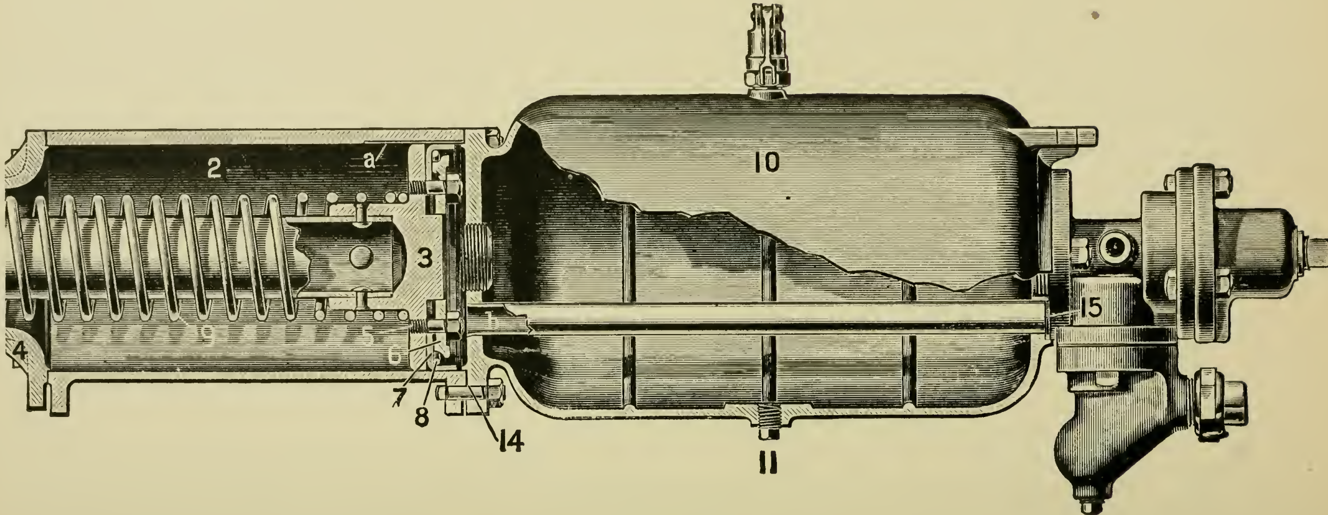



Plate 18 A.



Freight Cylinder, Reservoir and Triple Valve.

# AUXILIARY RESERVOIR.

It is not generally supposed that anything ever goes wrong with the auxiliary reservoir, as it is nothing but a storage tank for air.

It plays a very important part, however, in the action of the triple valve, and any leakage here, even though very slight, may seriously interfere with the functions of the most vital mechanism of the brake. Except in so far as such leakage will cause a slight drain on the pressure in the train-pipe, any trouble with the auxiliary reservoir is purely local, however, and affects only the one car in the train.

Since the freight and passenger reservoirs are of different construction, we shall have to consider them separately.

### PASSENGER "AUXILIARY."

The arrangement for quick-action brake on passenger cars is one which nearly all railroad men are familiar with.

There are only two points on this reservoir liable to leakage: the bleeding cock in the bottom and the pipe which leads from the triple-valve to the reservoir; for, as was said some time before, this pipe must be regarded as a part of the reservoir proper, being always open to reservoir pressure.

Any leak at these points makes the brake slow to act, especially in service or graduation applications.

Such a brake will be the last to set and the first to release.

On passenger cars equipped with the old automatic brake the triple-valve is suspended by a bracket from the reservoir, and this makes the nipple connecting the triple and the reservoir very liable to rupture at the thread.

### FREIGHT "AUXILIARY."

The arrangement of freight brake is shown on Plate 18A.

Leakage here is most liable to occur through the bleeding cock (release valve) shown on top of the reservoir; from the reservoir into the pipe (*b*) leading from the triple-valve to the cylinder, or most frequently of all, across the gasket joint between the reservoir and triple-valve (15) at the narrow bridge between the opening to the reservoir and the cylinder pipe.

In the two last cases the leak will show as a blow out of the triple-valve exhaust, which should not always be attributed to some defect in the triple valve itself.

# BRAKE-CYLINDER

While there are several different styles of brake cylinders, the arrragement of packing leather and piston head is practically the same in nearly all of them. For this reason we shall first consider that part and the peculiar ills to which it is heir. A section of a cylinder and piston is clearly shown in Plate 18A.

## CYLINDER LEAKS.

Leakage by the piston may occur through dry packing leather (7), a leather badly worn or imperfectly fitted, or some defects in the follower-plate (6), or the bolts (5) which hold it in place. If the leak is in any of these places it will produce a blow out of the vent hole *x*, in the back cylinder head while the brake is set.

Where the leather is to blame, plenty of good oil well distributed is the very best remedy. This softens the leathers and keeps them tight. A thorough cleaning occasionally, also, has a very beneficial effect, though in most cases leather packing will remain tight in spite of dirt if it is well lubricated.

Sometimes, although rarely, a leak occurs at the joint between the cylinder and front cylinder head (that nearest the triple-valve), and this may require a renewal of the gasket or possibly nothing more than a tightening of the bolts (14).

The result of the above difficulties will be to cause the brake to come off more or less slowly without any release or blow from the exhaust or triple-valve.

### "STICKING" OF BRAKES.

Sometimes a brake will remain "stuck" after the triple-valve has released, and can only be pried back with a bar. This may be due to the release spring (9) being weak or broken, or most frequently, on freight cars, at least, to a binding because of lack of oil. Sometimes the sleeve-piston (3) gets so corroded as to stick fast in the back head. When brakes remain set after the triple-valve has released, a careful examination of the levers and rods should be made to see that they do not catch at any point.

For "sticking of brakes" when the triple-valve does not release, see the following chapter.

# THE TRIPLE-VALVE.

(Plates 17, 18, 19, 20 and 21.)

There is probably no complaint more common amongst trainmen and engineers than "*The triple-valve sticks.*" It is safe to say that in nine out of ten cases where this complaint is made the triple-valve is *not* to blame at all. It is merely the index which shows a defect somewhere else in the apparatus, for the triple-valve being the automatic part of the brake, the foundation of the whole system, is the first part to be affected when anything else gets out of order. In quite an extended experience with air brakes the author does not remember more than a few cases where triple-valves were so defective as to be absolutely inoperative. They must be in very bad shape indeed if they will not work at all.

### BRAKE WILL NOT SET.

In case the triple-valve refuses to act, the first thing to examine is the auxiliary reservoir, as that may not have its full supply of air and, of course, as it is the air in the auxiliary reservoir that moves the triple-valve piston, a deficiency of pressure there will prevent the valve from acting. Sometimes the bleeding cock will be found left open or leaking, and sometimes there is a leak somewhere else about the reservoir of sufficient extent

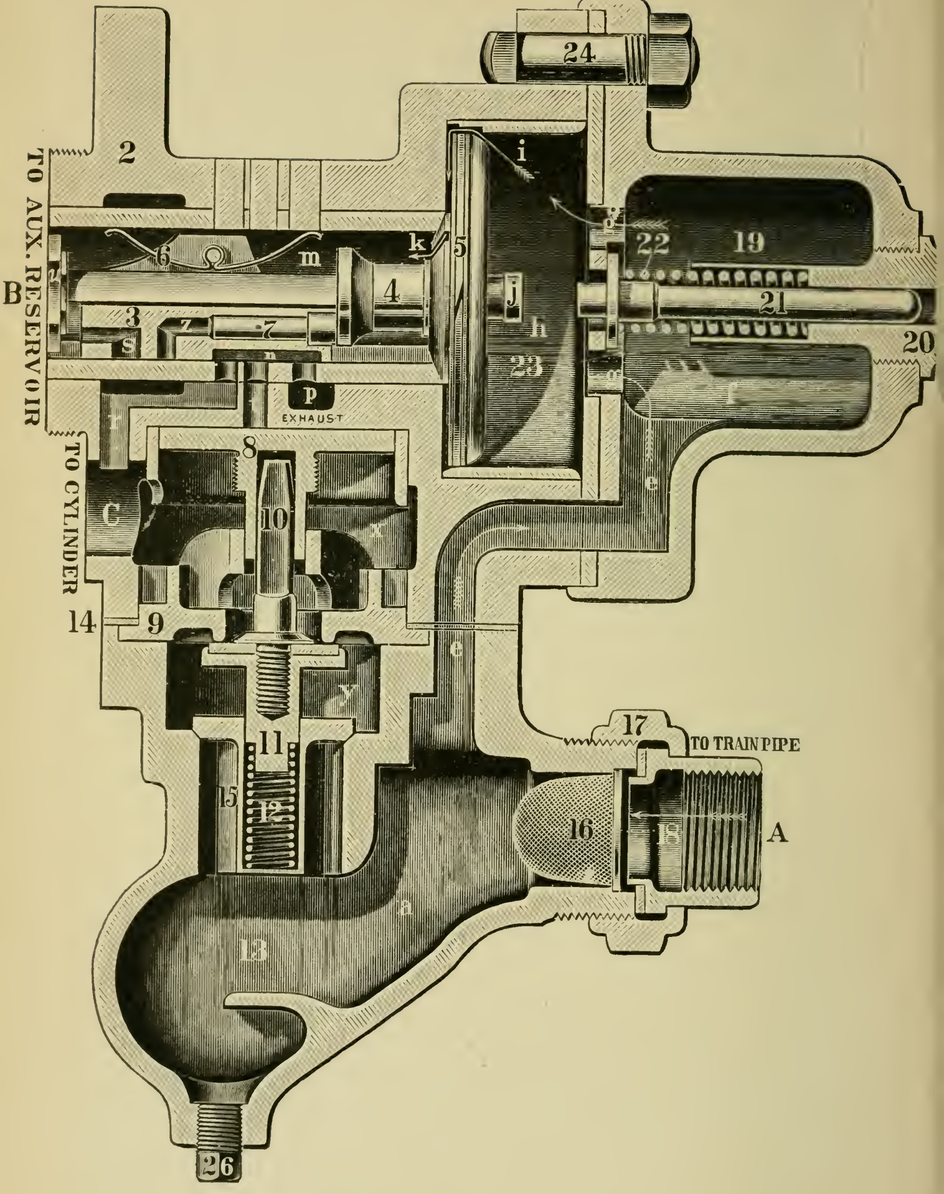

TO AUX. RESERVOIR
B
TO CYLINDER
TO TRAIN PIPE
A
EXHAUST
2
24
i
k
5
6
m
22
19
j
4
21
3
7
s
h
23
20
p
8
C
10
x
14
9
e
y
17
11
15
12
16
18
13
26



PLATE 17.

to prevent the proper accumulation of pressure. All the pipe connections about the reservoir should be very carefully examined.

In case the reservoir contains considerable pressure it is of course useless to look for leaks, and the attention must be turned elsewhere.

### DIRT IN STRAINER.

The strainer (Plate 17, No. 16) where the train-pipe connection is made should next be examined, as it sometimes becomes completely stopped with dirt. Strainers in this condition are shown on Plate 18*b*. They were taken from actual service.

They may be in such condition that they will permit sufficient air to filter through to partially fill the reservoir after a considerable length of time, and yet not allow the pressure to escape fast enough from the train-pipe side of the triple-valve to cause the brake to set. If there be plenty of air in the reservoir, and all the passages are found to be free and open, the only remaining inference is that the main piston itself is "stuck," and this should then be taken out and cleaned.

### FROZEN TRIPLES.

In very cold weather there is always the possibility that the valve may be frozen, especially if it is on a car near the head of the train and the main drum on the engine has much water in it. The author has located more than one negligent engineer, with his main drum half full of water, by discovering an excess of moisture in the triple-valve under the baggage car which he pulled regularly.

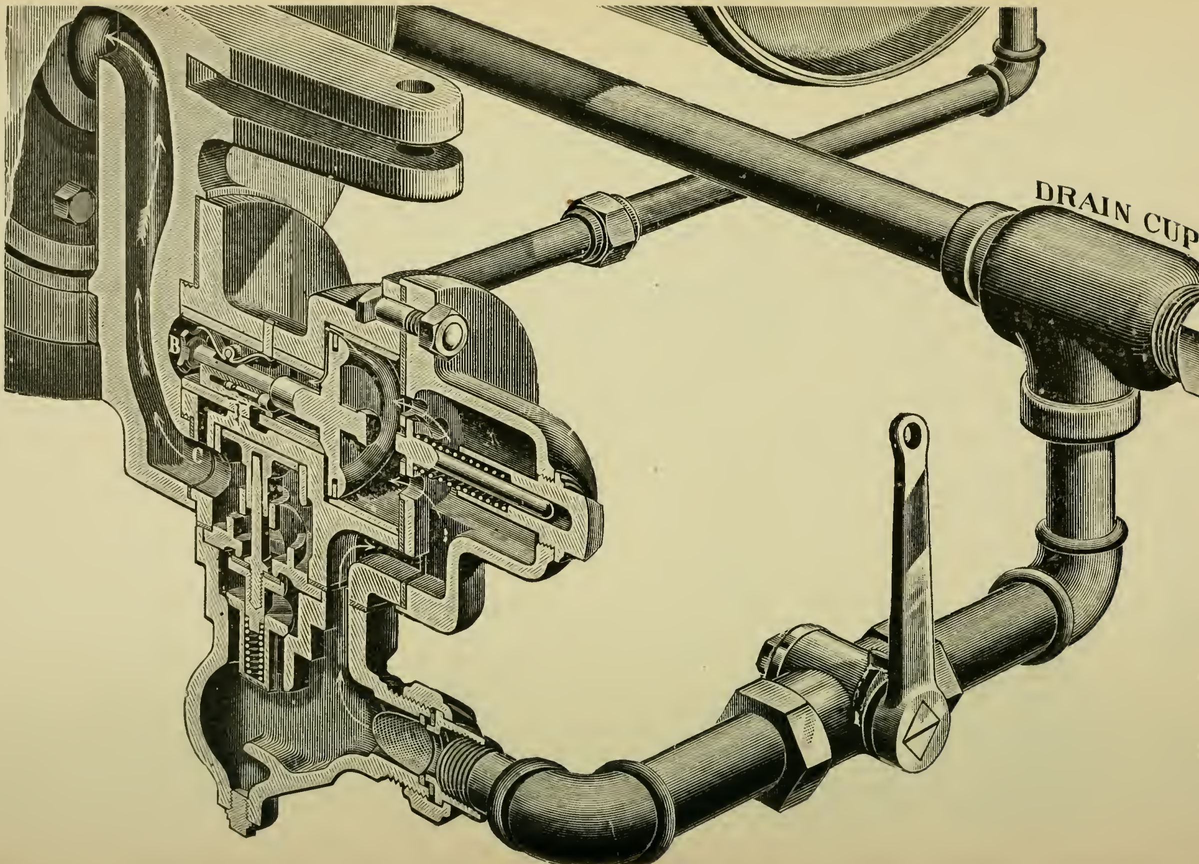





PLATE 18.

### BLOW FROM EXHAUST.

If there is a constant blow out of the exhaust of the triple-valve (or the pressure-retaining valve which is connected to the triple-valve exhaust) the first thing to determine is whether it comes from the *train-pipe* or *auxiliary reservoir.* This can be very easily done by cutting out the valve with the cut-out cock. If the blow does not stop for some time and then grows fainter gradually, there is little question but that it comes from the reservoir, but if it stops immediately and the brake sets, it is a clear indication of a leak from the train-pipe, between the triple-valve piston and the cut-out cock, the reduction on the train-pipe side of the piston causing the application of the brakes. If the leak is found to be from the reservoir, it must come either from an imperfect fit of the seat of the slide-valve, or more probably from leakage past the narrow bridge that divides the reservoir and cylinder passage in the gasket between the triple-valve and the part of the apparatus to which it is attached, it being fastened to the *cylinder* head on passenger cars and directly to the *reservoir* on freight equipments.

If the blow be from the train-pipe it is nearly always due to an imperfect seating of the emergency valve (Plate 17, No. 10), the bearing face of which being rubber will sometimes rot out from the action of oil. In many cases a little dirt under this emergency-valve will cause a sharp blow out of the exhaust, and this can frequently be dislodged by a number of emergency applications of the brake, the rush of air into the cylinder blowing the dirt along with it.

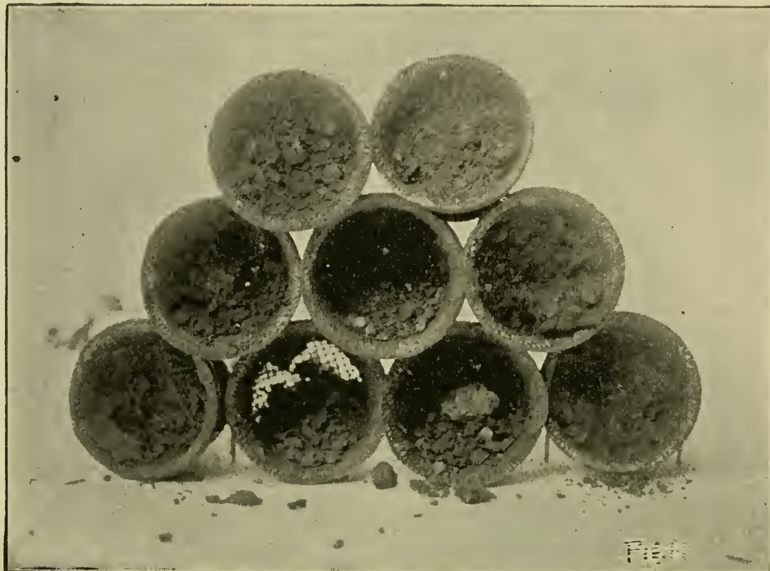


Plate 18b.

Sometimes the blow can be stopped, simply by cutting out the car, bleeding the reservoir, and then opening the cut-out cock suddenly.

### BLOW FROM EXHAUST—ENGINE AND TENDER TRIPLE.

In the triple shown in Plate 19 a blow from the exhaust is generally caused by a leak around the plug of the cut-out cock, and it can sometimes be stopped by simply turning the handle down and then up again. If this does not help, the plug must be ground in.

### STICKING AFTER EMERGENCY.

Brakes sometimes refuse to release promptly after an emergency application. If this "sticking" is accompanied by a violent blow from the exhaust when an attempt to release is made, it is a sure indication that the emergency-valve (Plate 17, No. 10) did not go back to its seat properly after the application, and something must be done to make it do so. Dirt lodging on the seat as described just above may be the cause, or it may be some defect in the apparatus itself, such as the spring (No. 12, Plate 17) being broken or very weak, or some binding of the piston (8). The author has a very distinct recollection of one case, in which such trouble was caused by a piece of scale from the casting lodging above the piston (8), just large enough when it stood on edge to block the piston so low that the valve could not seat. Hard rapping on the valve case would shake it down flat and stop the blow, but the next emergency action would set it up again, causing it to stick as before. A careful examination on taking the valve apart revealed the cause of the disturbance.

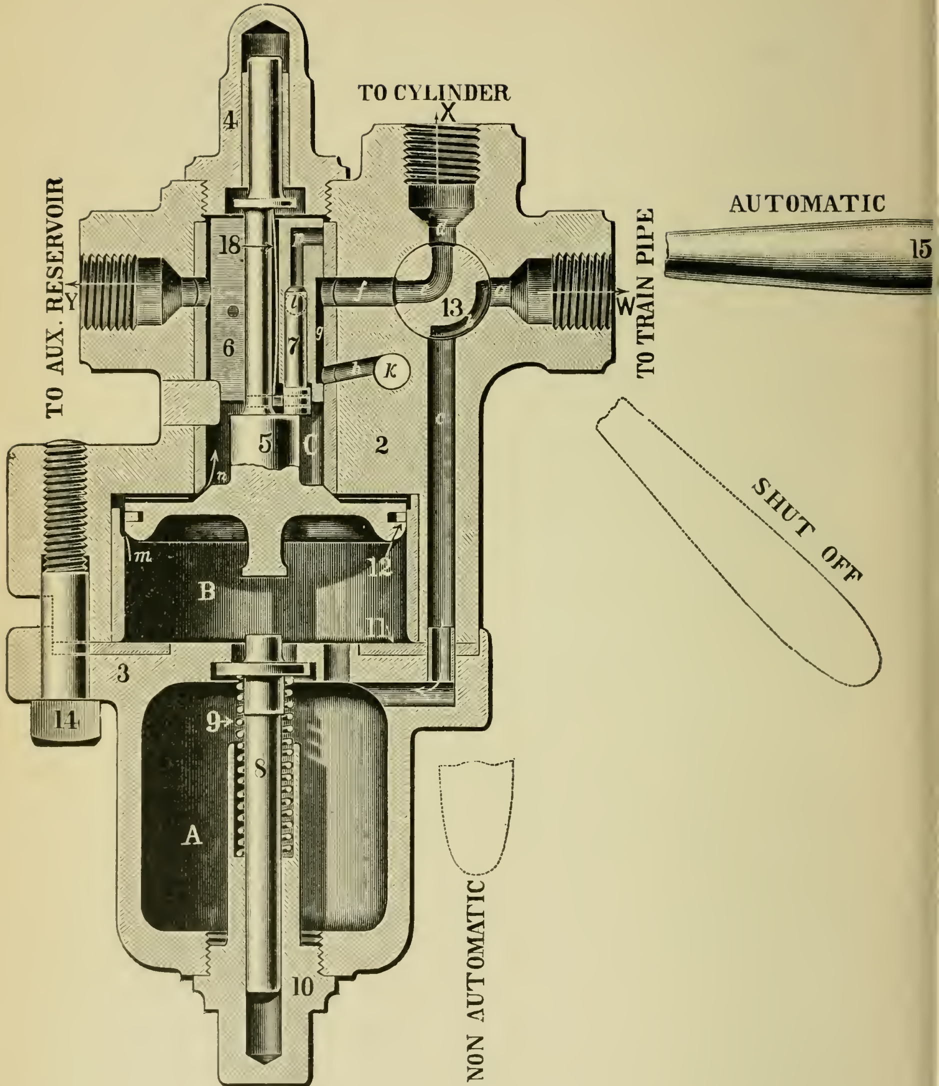

TO CYLINDER
X
AUTOMATIC
15
TO AUX. RESERVOIR
Y
TO TRAIN PIPE
W
SHUT OFF
NON AUTOMATIC
4
18
6
7
13
K
5
C
2
m
12
B
11
3
14
9
8
A
10



PLATE 19.

If the brake sticks after emergency, but does not blow from the exhaust when the excess pressure is thrown against it, it is an indication that the main piston (No. 5, Plate 17) refuses to be forced back to normal position. This may be from frost or dirt, but in the great majority of cases will be found to be simply because the pressure put into the trainpipe is not yet high enough to overcome that in the reservoir. Bleeding the reservoir slightly should release it; but if it does not, then the blame may fairly be laid on the valve. It must be taken apart, thoroughly cleaned, and then put together again.

### EMERGENCY ACTION WHEN NOT WANTED.

This may result from a very weak graduating-spring (Plate 17, No. 22), or a failure of graduating-valve (7) to unseat properly, either because the pin which controls it is broken, or else because it is surrounded with gum and dirt. It might also result in case the main piston (5) should stick just enough to require a very heavy reduction to move it. This is a very annoying and difficult trouble to locate. The first thing to do is, of course, to find out which triple-valve it is that is giving the trouble. This can best be done by stationing men along the train to watch the action of the brakes under the cars while the engineer makes an application. If the train is too long to be conveniently watched in this way, begin with the first half. If this by itself does not give the defective action complained of, it is a manifest fact that the offending triple-valve must be in the latter half of the train. A few careful tests of this nature will soon locate the car on which is the defective valve, and when so

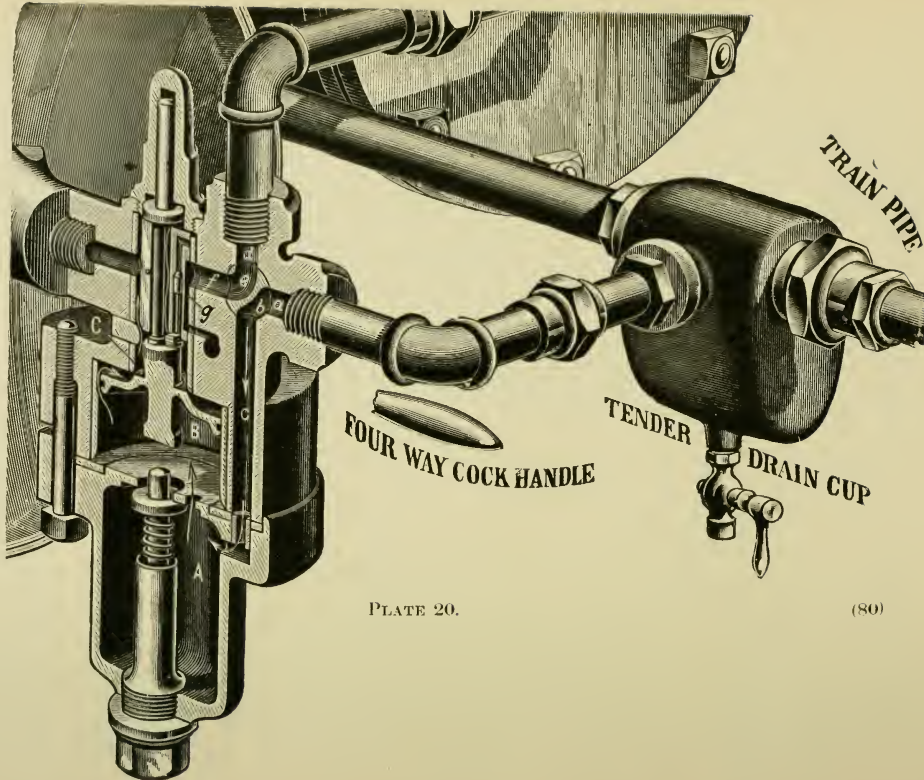



PLATE 20.

located it can be cut out until the repairer can fix it. The exact operation of a valve such as the one just above described is as follows: On the first light reduction in the train-pipe it will be the last to apply, and when it does set it will go on very violently; this quick action causing a full application of all the other brakes in the train.

### BRAKES SETTING WHILE RUNNING.

This is almost invariably an indication of a reduction of the pressure in the train-pipe, either through leakage, equalization (air flowing from a car having a high pressure to one having a less pressure), the separation of the train into two or more parts, the bursting of a hose. I say *almost* invariably, because there are cases in which the brakes may set while running, without any reduction of the train-pipe pressure. For example, this sometimes occurs on a driver or tender brake as a result of leakage past the four-way cock plug (No. 13, Plate 19).

### ACCIDENTAL EMERGENCY APPLICATION.

If the setting of the brakes is sudden and violent, either one of the last two causes mentioned above is generally to blame, *i. e.*, either a hose has burst or the train has separated. Anything else, however, which would make a large and sudden reduction in the train-pipe would cause the same action, such as the opening of a conductor's valve or the blowing out of a plug, gasket or pipe fitting.

### ACCIDENTAL SERVICE APPLICATION, OR "DRAGGING OF BRAKE."

This is one of the most frequent troubles that arise in the use of the automatic brake, and, as was stated before,

is seldom the fault of the triple-valve. When it is once clearly understood that the brake is dragging as a result of some reduction of pressure somewhere in the train-pipe, and that the triple-valve would not be doing its duty if it did not respond to this reduction, then a long step has been made towards locating the difficulty and remedying it. The first thing to do is to find out whether the reduction is due to equalization or leakage. If it is the former, a part of the train only will be affected, but if the latter, the trouble will be general throughout the train. In either case, careful handling of the engineer's valve will generally prevent any trouble or delay of a serious nature, as the brakes will cease to drag if the air is fed into the train-pipe as rapidly as it is leaking out, and if the head cars are not charged with a higher pressure than the rear ones when the brakes are released.

### TRIPLE RELEASING WHEN NOT WANTED.

This may be due to leakage around the auxiliary reservoir or its connections, failure of the graduating-valve (No. 7, Plate 17) to seat tightly, increase of pressure in the train-pipe through leakage back from the main drum through engineer's valve, or a wave of pressure in the head end of the pipe when the exhaust is suddenly closed. The last named difficulty only occurs on long trains, and the third one generally on but one or two cars or the lone engine.

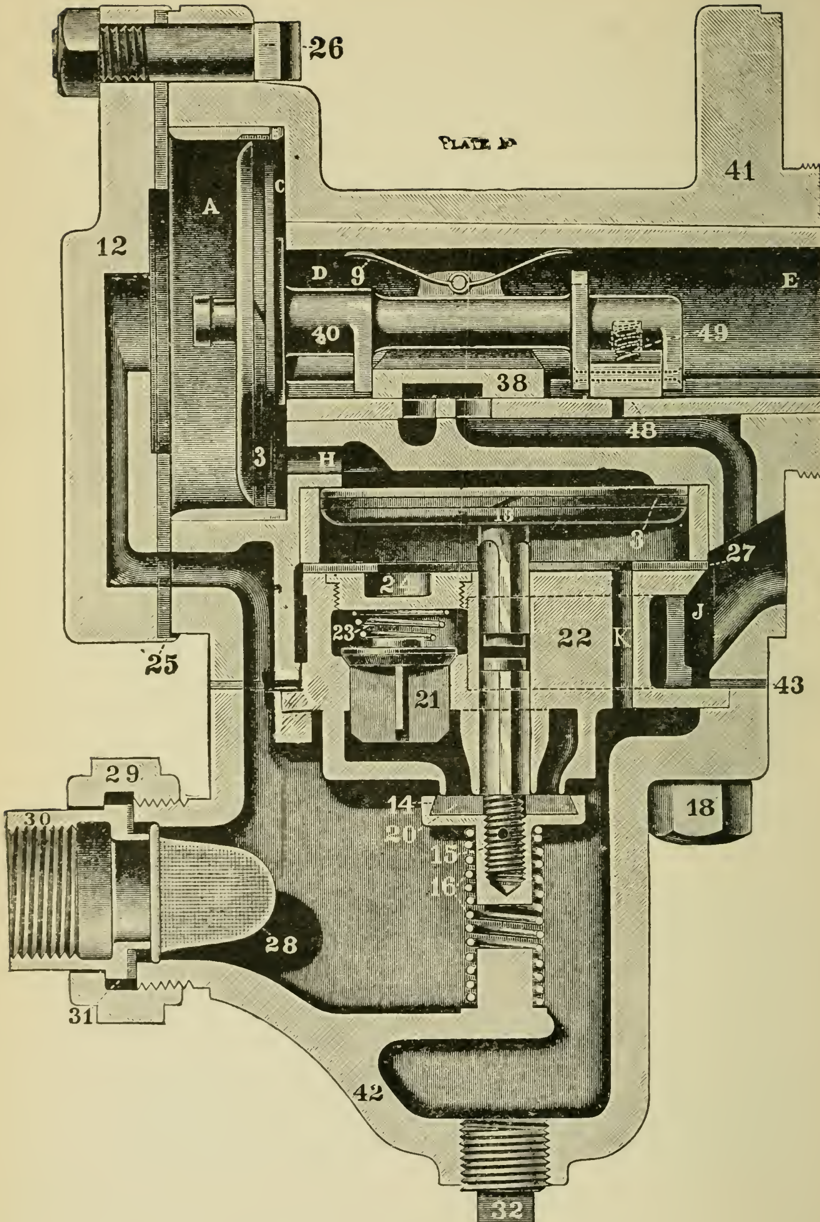
### DRIVER-BRAKE TRIPLE RELEASING.

The driver-brake is the one most apt to give trouble releasing when it should remain set, and this is for two reasons, or speaking more accurately, several reasons.

First, being at the extreme head end of the train-pipe it is most sensitive to the wave of pressure caused by the closing of the engineer's valve exhaust; second, the cylinders are seldom, almost never, tight; third, the travel of the pistons is generally more than it should be; and fourth, the reservoir is often too small for the size of the cylinders. It may be asked by some, why the escape or excessive expansion of the air fed to the *cylinders* from the triple-valve should have such an effect on the action of the triple, when that action is supposed to be controlled by a piston balanced between *reservoir* and train-pipe pressure. All that I can say in reply to this is, that the greater freedom of expansion on most driver-brakes seems to make possible a heavier reduction in the reservoir pressure during the short space of time in which the graduating valve remains open; so that the valve is left nearer the releasing point as regards pressure than is commonly the case. I have seen it demonstrated repeatedly by experience, that driver-brakes which caused trouble by releasing at the wrong time could be effectually cured by simply reducing the travel of the pistons, or putting on a larger reservoir.

### New York Triple.

Plate 21 shows the New York triple that is at present in most general use. It differs from the Westinghouse in the use of a larger emergency piston, which is directly exposed at all times to pressure in the auxiliary-reservoir on one side and train-pipe on the other; and, further, in the use of a small slide-valve for a graduating-valve in place of the poppet-valve in the main slide-valve found in the Westinghouse. The general principle of operation is


26
PLATE 10
41
C
A
12
D
9
E
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49
38
48
3
H
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22
K
J
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PLATE 21.

so similar as to permit of the use of the same general method of treatment as that given just above. Where the brake sticks after an emergency application, it is generally because the emergency-valve (20) and its piston (13) has gone back to its seat after equalization. In this case, a heavy blow from the exhaust will show itself as soon as the train-pipe pressure is increased above that in the auxiliary-reservoirs, because, the emergency-valve being open, the train-pipe pressure has direct communication with the cylinder, and as soon as the main piston and valve are moved to release position this pressure will find an escape through the exhaust. This action of the valve may be due either to the emergency piston being dirty or the spring (16) being broken or weak.

In case there is a constant blow from the exhaust port of this valve (or through the pressure retaining-valve, which amounts to the same thing), and still the brakes set and release properly, the first thing to do to locate the trouble is to determine in the manner previously described whether this blow comes from the train-pipe or auxiliary-reservoir.

If the brake sets immediately on being cut out, indicating that it is train-pipe pressure that is escaping, the valve must be examined to see whether it is from dirt on the seat of the emergency valve (20) or an imperfect bearing of the gasket which forms the joint at (27).

If, on the contrary, the brake does not set when cut out, but the blow grows gradually fainter and finally dies out entirely, the bearing of the small slide-valve (48) must be examined as also the gasket joint between the triple and the reservoir as these two points are the ones at which the reservoir pressure is most apt to escape.

# PRESSURE RETAINING VALVE

While this is one of the smallest pieces of apparatus used with the air-brake, it is, on mountain roads, one of the most important. While it is one of the simplest parts, it is one of the least understood. Being so simple it is not very liable to get out of order. This is not really a part of the brake proper, but is in a certain sense an interference with the normal action of the brake. When the handle is not in operative position it has no effect any more than if it did not exist, but when it is in operative position (that is, when the handle stands at right angles to the pipe) it prevents the entire release of the brakes; holding about 15 or 20 pounds in the cylinder after the triple-valve has released so as to prevent the train from gaining too much headway while the reservoirs are being recharged.

Any dirt on the seat of this valve will, of course, destroy its function entirely, but cleaning is all that is necessary to repair it.

### BLOW FROM RETAINER.

If the air is blowing out of it when the brake is not set, the trouble is in the triple-valve, and not in the retainer at all. If the retainer be missing entirely there is no interference with the primary functions of the brakes, and if a blow be detected at the end of the broken pipe it must

not be plugged up, as this will entirely prevent the release of the brakes. This pipe is nothing more than the exhaust from the triple-valve, and if a brake blows hard from the exhaust it should be cut out until the triple-valve can receive proper attention. For instructions in such a case, see the chapter on "Triple-Valve."

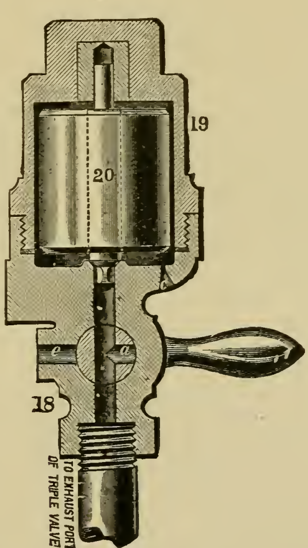



PLATE 22.—PRESSURE RETAINING VALVE.

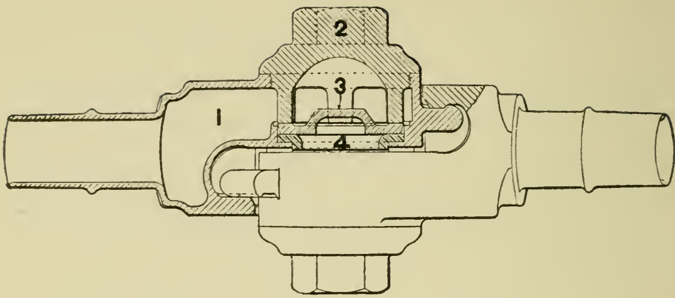



Fig. 1.

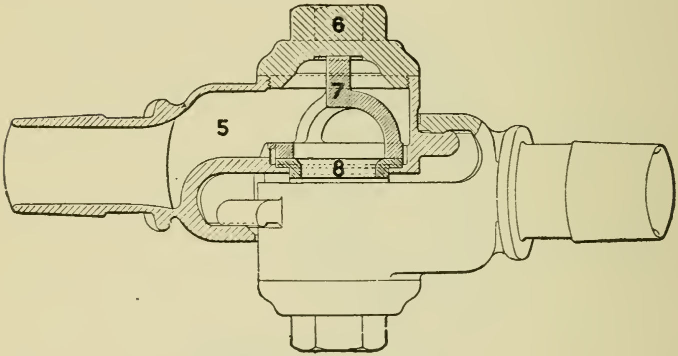



Fig. 2.

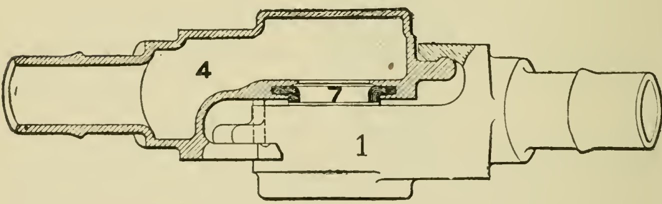



Fig. 3.

Plate 23.

# HOSE COUPLING

Before taking up the subject of Foundation Brakes, let us now give a little attention to the hose coupling. The care required by this part is mainly necessitated by wear or destruction of the packing rubber or gasket, which must be occasionslly renewed.

With the designs in most common use (shown in Plate 23, Figs. 1 and 2) this renewal can most readily be effected by taking the hose off from the car to some place where the cap on the back can be fastened in a vise and a rod inserted in the nipple as a lever to turn the coupling-body. These caps are generally screwed down so firmly that it is quite useless to endeavor to get them loose while on the car. The average life of these rubber gaskets is considerably shortened by the pernicious habit many trainmen have formed, of hooking up the hose with the point of the dummy coupling right in the port opening. This destructive practice cannot be too strongly condemned.

### WESTINGHOUSE'S IMPROVED COUPLING.

This, the latest form introduced, is shown in Plate 23, Fig. 3.

In this the gasket 7 is simply inserted in a taper groove around the port opening, the idea being to permit of the renewal of the gasket without the necessity of removing

the coupling from the car. The main trouble with this design arises from hardening of the gasket in the groove or rusting of the inner surface, making it difficult at times to clean out the groove, or get a new gasket in so as to make a tight joint.

If, on attempiing to extract the old gasket, it breaks in pieces and sticks obstinately, it is best to put on a new hose and take the old coupling to scme place where the groove can be scraped out with a tool.

For instructions as to the best thing to do when a leak is detected in a coupling connection, while on the road, see the chapter on the "Train-Pipe."

# FOUNDATION BRAKES.

Under this head are iucluded all the levers, rods, beams, shoes, etc., that are used in conjunction with the air-brake proper. This is a subject so vast that anything like full consideration of it would require a special treatise; therefore we shall touch on it here only in a very general way. For convenience, let us divide the question into the following heads: Car-Brakes, Tender-Brakes and Driver-Brakes.

## Car-Brakes.

Probably the most troublesome disease under this head is improper

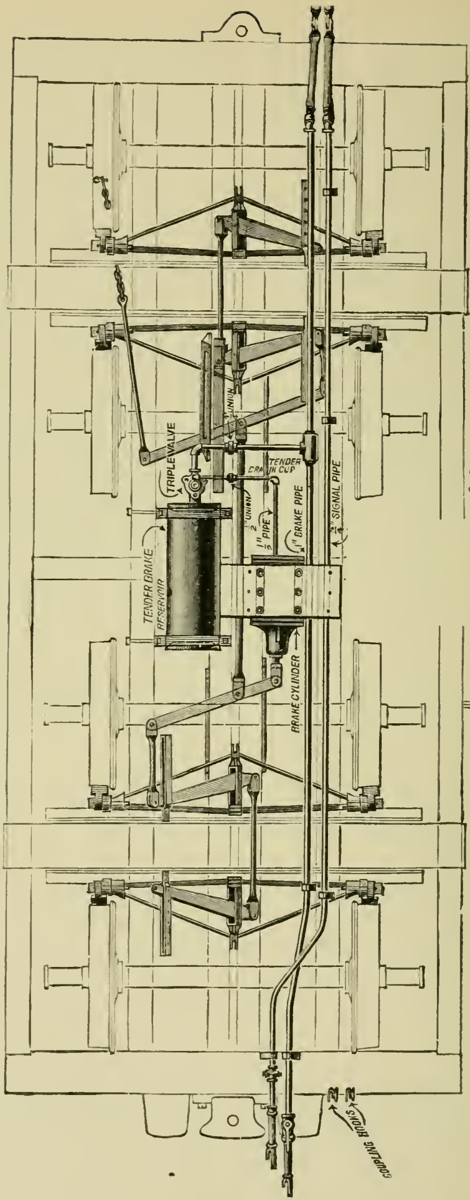
### ADJUSTMENT OF LEVERS.

Even when the piston travel is right the angle of the levers is frequently wrong. All levers should stand as nearly at right angles to the rods as is possible. Any other position interferes with a proper distribution of the braking power, to a greater or less extent, according as the position of the levers is more or less oblique.

The proper

### PISTON TRAVEL

is, for passenger cars, about 8 inches, and for freight cars about 6 inches. A constant struggle should be main-




TENDER BRAKE LEVER ARRANGEMENT.



PLATE 24.

tained to keep this as nearly uniform as possible, and any great variation either way will be sure to show itself in the performance of the brakes in service. With too long a travel the brakes will not hold properly, and with too short a travel they will stick.

If the travel be reduced to an extremely small amount all the air admitted to the cylinder will escape through the leakage groove, and the brake thereby be rendered useless entirely.

Let us repeat, too much stress cannot be laid upon the necessity of keeping the foundation brakes properly adjusted. Care in this respect will reduce both the number of wrecks and flat wheels. This applies not only to car-brakes, but to driver and tender-brakes as well.

If levers bend they should be made stronger.

If rods break they should be made thicker.

If beams collapse better ones should be substituted.

What sense is there in spending thousands of dollars for the latest improvements in triples, engineer's valves or pumps if the braking force developed by them is lost through the breaking of beams, rods or levers? What does it profit a road to put expensive driver-brakes on an engine if they are not kept in operative condition?

No one should remain satisfied with a brake that simply takes hold; it should be made to take hold just as hard as is possible without sliding wheels. It is a good rule not to let a single wheel run without a brake if there is room to put a brake on it, but it is even more important after it is on to take proper care of it.

The author has seen a number of instances where two trains, to all appearances exactly similar as to brake

equipment, were stopped on the same track, but showed remarkable differences as to the length of stop, one sometimes running nearly twice as far as the other.

Investigation invariably revealed the fact that the difference was largely due to the condition of the foundation brakes.

### Tender-Brake Levers.

Many, if not most of the designs, of lever arrangement under the tenders are exceedingly poor. In many cases the whole construction may be called one great disease. Such can only be cured by complete reorganization.

About all the engineer can do with this brake is to see that the cylinder is properly oiled, the slack adjusted, and the water frequently emptied from the drain cup. A tender should have about the same piston travel as a freight car (6 or 7 inches).

The modified form of the Stevens system, illustrated in Plate 24, is about the best lever arrangement for tenders. It is simple, compact and easily adjusted, three points of advantage of particularly great importance where the available space is limited as it is under most tenders.

### Driver-Brakes.

A good driver-brake is a great boon to an engineer, and if properly proportioned is of greater assistance in stopping a train than the reverse-lever. It therefore behooves the engineer to take good care of it, and in order to be able to do this properly he must make a careful study of the peculiar eccentricities of that driver-brake which comes under his immediate charge, or of all classes of driver-

brakes if he has to run many engines. In the latter case it is of course considerable of a task, and better results can be expected where an engineer always has the same engine.

Every driver-brake has its own peculiarities, due to differences in location, and the proportion and arrangement of parts. Some push-down brakes have very long cams, and such generally require frequent adjustment, for if they are allowed to get a little too much slack they will soon take hold too violently and grind or lock the wheels. Some have very short cams, and these will generally run much longer without adjustment. In some the cylinder is closer to the firebox than in others, and as a consequence the packing leather dries out more rapidly, to counteract which it must be very frequently oiled.

### PUSH-DOWN BRAKE.

Plate 25 illustrates the most common form of push-down driver-brake. The shoe heads should be so adjusted that the shoes will hang with their faces about parallel with the tread of the wheel, except in winter, when difficulty is experienced from ice collecting around and on the face of the shoe, when the head should be so adjusted that the end of the shoe toward which the tread of the wheel moves, shall hang nearer to the wheel than the other end. This will serve better to scrape off the snow and ice. The idea will be more clearly understood by reference to Plate 25*a*. This rule cannot, of course, apply to engines which run backwards as much as forwards. It applies equally, however, to the style of brake shown in Plate 26, which is now used very extensively on heavy engines.

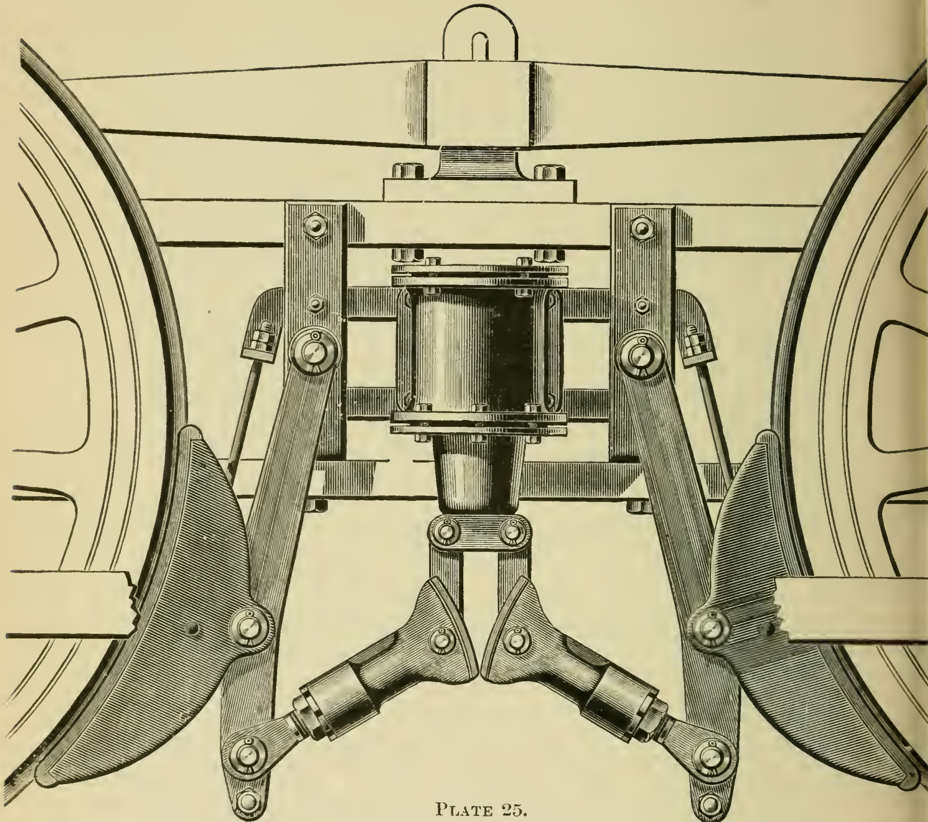


PLATE 25.

PUSH DOWN DRIVER BRAKE.


PLATE 25A.

### OUTSIDE EQUALIZED BRAKE.

In connection with this design (Plate 26), very large cylinders are generally used, and this makes it very important to guard against allowing the pistons too much travel, for this weakens the braking force very materially.

To be sure the auxiliary reservoirs are supposed to be enough larger to obtain the proper proportionate expansion or equalized pressure, but it must be remembered that this calculation is based on a moderate travel of the pistons and not by any means on the full capacity of the cylinders.

These cylinders are generally of the pull-up type, the same as shown in the cut, with a stuffing-box around the piston rod.

This requires constant watching to prevent loss through leakage, because the packing around these rods is so liable to fail. The author has never seen a cup leather packing around a rod which did not give more or less trouble, and thinks almost any other form of packing would be more satisfactory.

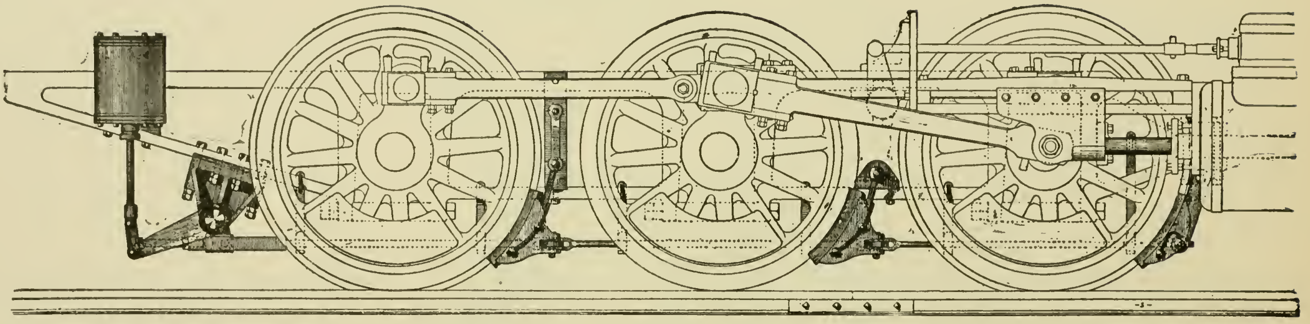


PLATE 26.

OUTSIDE EQUALIZED BRAKE.

# SPECIAL CASES.

There are forms of apparatus, which while not at this day recognized as standard on any road, are still in use to a greater or less extent. For instance:

## Plain Freight Triple.

Plate 27 illustrates the first of these special cases. A large number of these valves were put into service prior to the introduction of the quick-action triple, most of them having been applied to cars used in fast freight runs. As far as general construction is concerned it was simply a plain triple with a four-way cock, but because of a couple of weak points in design it has given more trouble to trainmen than, perhaps, any other form of triple ever brought into general use.

### BRAKE STICKING.

When one of these brakes refused to release, the trouble would begin. With an ordinary triple this could be easily remedied by letting a little air out of the bleeding-cock. These brakes were not provided with bleeding-cocks. In place of them a groove (shown just to the left of Fig. 4 in the cut) was made in the four-way cock plug in such a position that when the brake was cut out, this channel

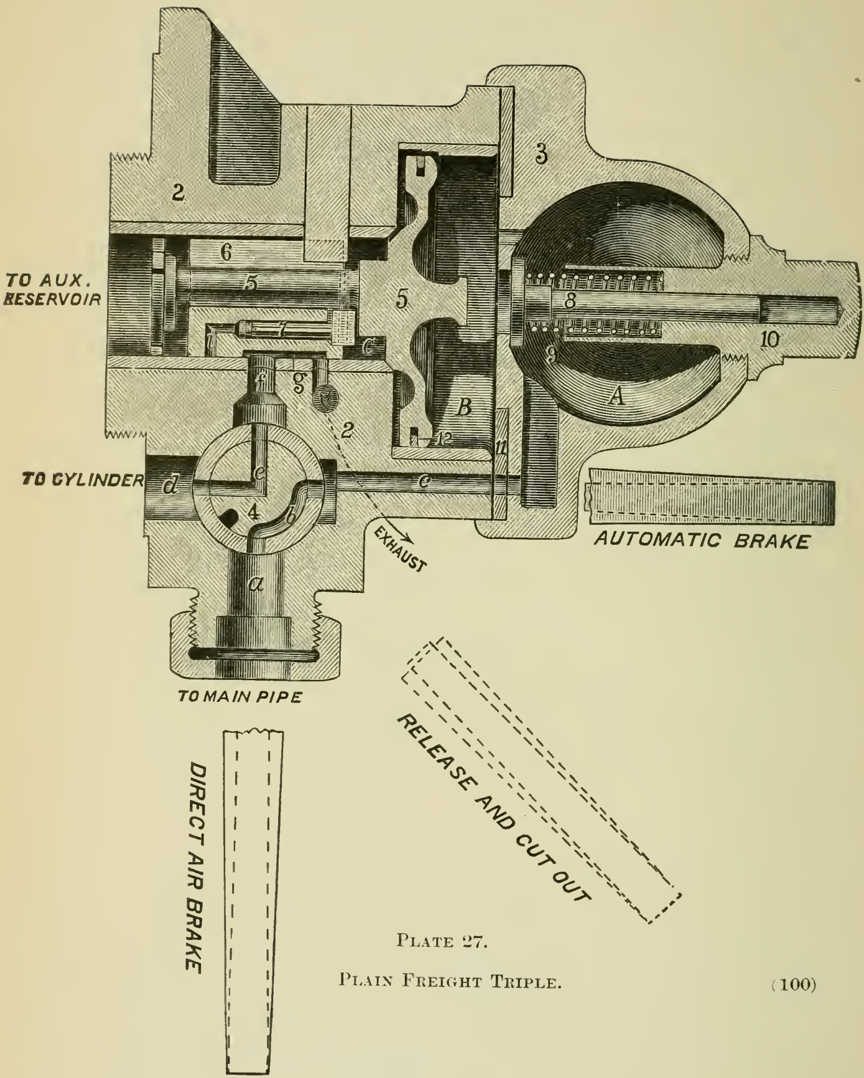



PLATE 27.

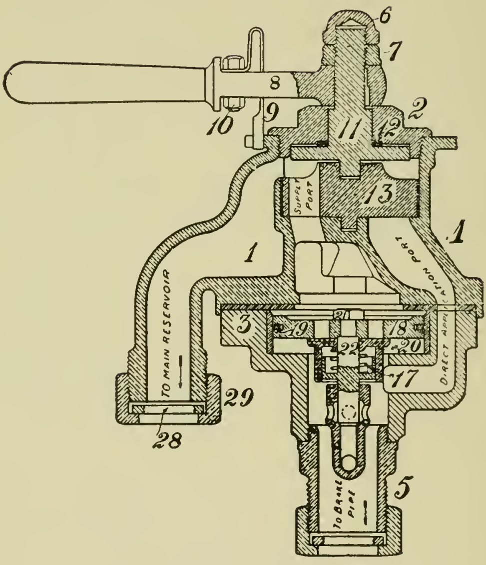
PLAIN FREIGHT TRIPLE.

would connect the cylinder with the atmosphere, and the brake would come off. As soon as it was cut in again, however, it would reset, and so it would continue. When cut out it would release, when cut in again it would set; when cut out again it would again release, and if the handle was turned down to "straight air" position it would set again. Finally the trainman in disgust would abandon all attempts to make it work, leaving it cut out when it might have been used had he understood how to fix it. All this trouble arose from the fact that the groove in the four-way cock (through which the brake released when cut out) bled the *cylinder* but not the *reservoir*. As long as the pressure in the reservoir was greater than that in the train-pipe, the main piston was held in application position, while the opening to the cylinder could be shut and the exhaust from the cylinder opened by turning the four-way cock to cut out position.

This would not reduce the pressure in the reservoir, and so, as soon as the valve was cut in again, the brake would reset.

In most of these cases the reservoir pressure could have been reduced simply by moving the handle clear around beyond the straight air position as far as it would go, for this would bring the exhaust groove opposite the port from the reservoir, and allow the reservoir pressure to escape until the piston and slide-valve moved back to cut off the opening.

Another defective point about this design was that the piston was not allowed sufficient travel to pull the slide-valve entirely past the opening to the cylinder.




EQUALIZING VALVE OF 1888.

PLAE 28.

BRAKE REFUSES TO SET.

As a result of the above mentioned condition, this triple becomes entirely inoperative when the graduating pin breaks, because the air pressure closes the graduating-valve, thus shutting off the only passage through which air might have reached the cylinder.

There are at the present day many of these valves, which, though in good condition, are allowed to run *cut out* simply because of the lack of a proper understanding of them by the trainmen.

## Equalizing Valve of 1888.

Plate 28 is taken from Westinghouse temporary catalogue for 1888, plate C. 7, and was about the first form of the present equalizing valve put into service. Most of those sent out have since been removed, so that, not so much with a view to practical usefulness, as in the light of an item of interest, we here insert a few words concerning it.

It differed from the later style in the arrangement for permitting the air, in the release of the brakes, to pass to the train pipe directly through the equalizing piston, the ports (shown in the plate) being closed after equalization, by the cup valve 20, held to its seat by the spring 17. The main difficulty with this arrangement was that, if from any dirt or imperfection, the valve 20 failed to seat properly, whatever pressure was reduced from the cavity above the piston in service applications was supplied by air leaking back from the train pipe, the equalizing valve therefore failing to open.

PUMP GOVERNOR.

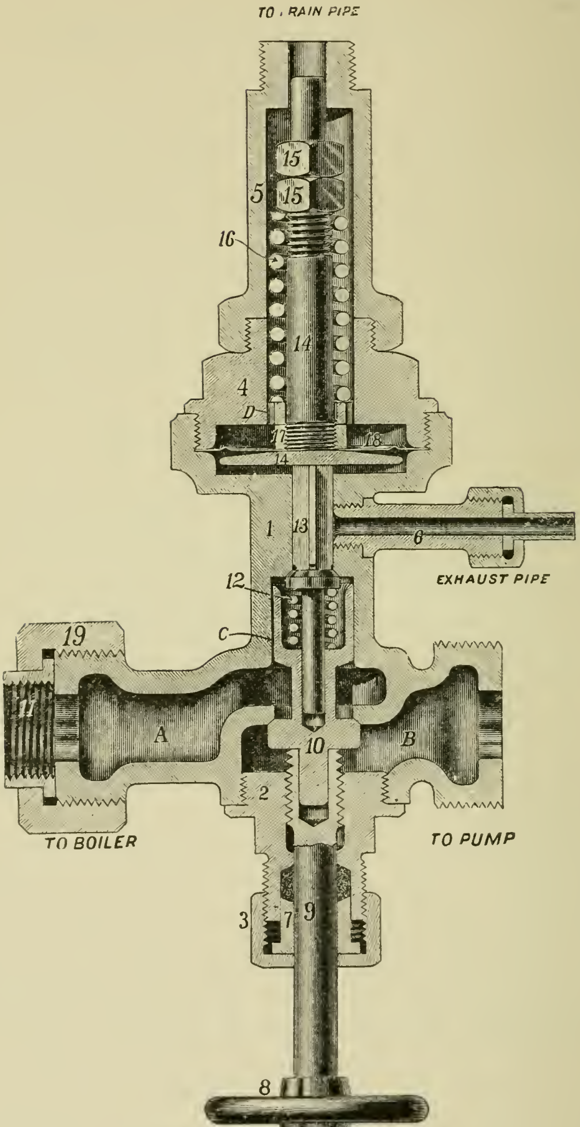





PLATE 29.

One noticeable thing about this valve was that on short trains it did not blow from the service exhaust when the handle was thrown to release position, the reason for which will be obvious on a moment's study.

## Old Style Governor.

Plate 29 is a sectional view of a pump governor many hundred of which are still in use, and which for convenience we shall call the "Old Style Governor." They were never very satisfactory, and in fact, but very few of those coming under the writer's personal observation were of any value at all. They were defective in theory and consequently a total failure in practice. The majority of them never would stop the pump at all. In operation they depended to a certain extent on back pressure from the pump, acting upwards on valve 10, and of course as soon as this back pressure disappeared, nothing remained to hold valve 10 shut.

It seems reasonable to suppose that if a good stiff spring were substituted for the spindle 9 (which is entirely superfluous) the spring being so arranged as to exert an upward pressure on valve 10, the device could be made to work. The author makes this suggestion for some of his readers to try. Another remedy, prescribed by Mr. Woods, of the C. & N.-W. Ry. at West Chicago, and successfully applied to quite a number of engines under his charge, is to substitute for the spindle 9 a stem and piston, the piston working in a cylinder screwed in in place of the stuffing box 2, and having its lower side connected with the exhaust pipe 6 by means of a small copper tube. With this arrangement, as soon as the air

pressure unseated the valve 13 the steam from the exhaust pipe flowed around and against the under side of the piston and forced the valve 10 to its seat.

Of course in making such experiments it will be necessary to see that the rest of the apparatus is in proper shape. The cup piston on the end of valve 10 must be a good snug fit, the small spring 12 must be sufficiently long and stiff to readily seat valve 13, and valve 13 itself must be short enough to rest squarely on its seat, and still have a small space between its upper end and the diaphragm plate. Particular attention must be given to the last named point because, as will be readily seen, no pressure can be accumulated through port C, on top of valve 10 to open it, unless valve 13 is shut.

# APPENDIX.

The plates shown under this head are from photographs of various parts of the air-brake apparatus in a diseased condition. Most of them were obtained through the kindness of Mr. G. W. Rhodes, superintendent motive power, C. B. & Q. R. R., but the author's thanks are also due to a number of others, who generously assisted him in making the collection.

## PLATE 30.

The first of the set shows an upper valve chamber bushing, taken from an 8-inch pump, together with a number of disabled air-valves. No. 1 is broken in a manner not at all uncommon, and yet one which, when it occurs in a lower discharge-valve of a 6-inch pump, is very apt to deceive the "doctor," for when he touches it underneath it feels all right, has the proper lift, etc. No. 2 has the head broken loose from the wings and forming a kind of collar around the stem or projection above. Nos. 3 and 4, as will be readily seen, are each broken in two pieces. The projecting knob on top of


PLATE 30.

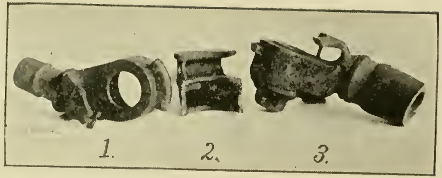



PLATE 32.

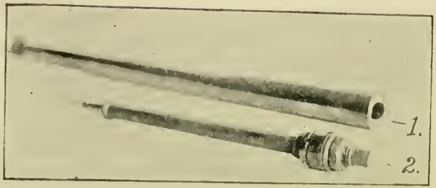



PLATE 31.


PLATE 33.

No. 3 being missing entirely. This knob when broken off frequently wears round, like a little marble, and sometimes causes trouble by getting stuck somewhere in some pipe or port. No. 5, like No. 1, is but very little worn, and serves particularly to emphasize the importance of having these valves made of the very best material. No. 6 speaks for itself.

PLATE 31.

No. 1 shows a main piston-rod taken from a pump, broken at the upper end where the head was screwed on. No. 2 is a main valve rod and lower piston-valve, with an adjustable stop attached. It is evidently "home-made." If this adjustable stop should happen to be made a little too short, the main valve would travel too far down, the lower small packing-ring expand below the bushing, and the remainder of the trip have to be made with hand-brakes.

Beware of adjustable stops.

PLATE 32.

What an interesting trio we have in Plate 32. Nos. 1 and 2 are evidently the result of the coupling being caught and smashed between two cars. No. 3, it will be noted, has the upper lug bent downwards, a condition not infrequently resulting from a blow from a link or pin in the hands of some brakeman, in an attempt to stop a leak.

PLATE 33.

No. 1 shows the body of a N. Y. triple valve, which has evidently received some "hard knocks." No. 2 is a striking object lesson for the men who clean and repair

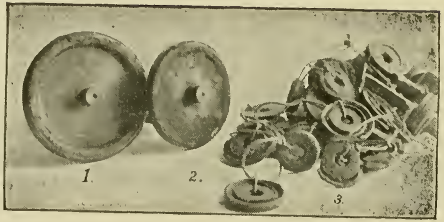



PLATE 34.

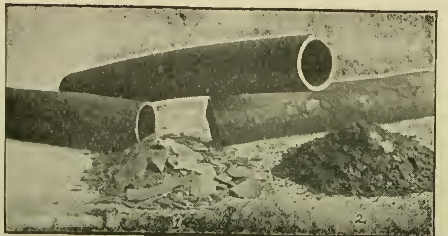



PLATE 35.

PLATE 36.

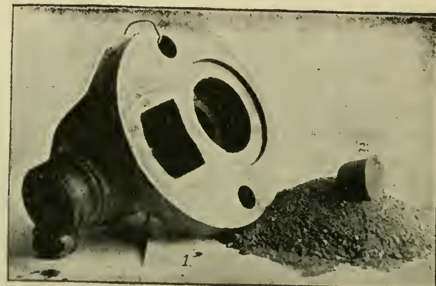



PLATE 37.

triple-valves. The marks of the hammer clearly show the cause of the crack. When a gasket joint sticks, *persuasion* generally works better than *force* in getting it loose.

PLATE 34.

Nos. 1 and 2 are two triple valve pistons, on which the gum and dirt are "beautifully" shown. The smaller one, No. 2, was taken out of a freight triple on a car which came in with 4½-inch flat spots on eight wheels, because the brake "stuck."

The lot of emergency-valve gaskets, marked 3, show the effect of neglect and carelessness (particularly in the use of too much oil in the brake cylinder) and graphically illustrate a frequent cause of the "blow from the triple-valve exhaust" about which we hear so much complaint.

PLATE 35.

Plate 35, though not very beautiful, is exceedingly instructive.

The sections of train-pipe shown were taken from under a refrigerator car, the pile of dirt numbered 2 being the accumulation shaken out of a piece only 8 feet long.

Pile No. 1 was shaken out of a 16-foot length of *new* pipe, and most impressively teaches the need of blowing out all pipe thoroughly, in setting up new work, before connecting the valves.

PLATE 36.

The triple screens shown in Plate 36 are fair samples of hundreds that are running at the present day. They are shown just as they were found. The two large, tin,

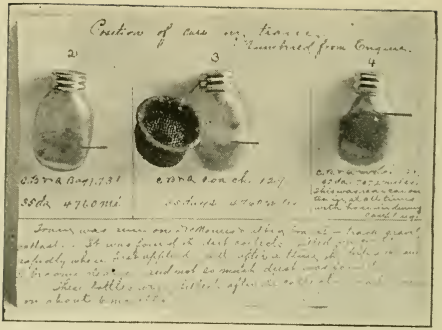



PLATE 38.

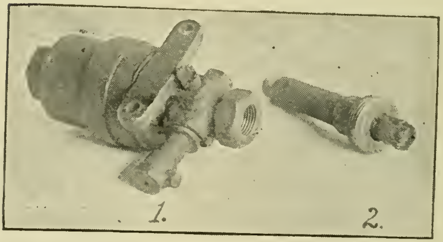



PLATE 39.

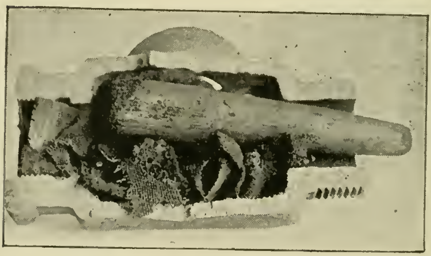


PLATE 40.

funnel-shaped extensions shown at one side were put on to hold the dirt found in the pipe next to the screen; the screens not being large enough to hold it all. The accumulations are mostly a mixture of *pipe, scale, cinders, sand, sponge, corn,* etc.

The effect of such a condition of affairs can be better appreciated when we reflect that all the air to operate the triple must pass through such a mass of dirt. With some of the samples shown a service application is still possible, but not an emergency stop.

PLATE 37

Plate 37 illustrates something similar to Plate 36, except that the case is a little more aggravated. No. 1 shows the check-valve case of a No. 1 New York triple-valve; No. 2 a pile of dirt taken from the train-pipe at the union connection, with the screen lying on top.

PLATE 38.

To get some approximate idea of just how rapidly dirt will collect at the triple-valve screens, a dirt collector, in the form of a drain cup, with a strainer like the strainer in the supply-pipe to an injector, was placed on a number of cars just at the triple connection and the accumulations put in small bottles, which are shown in Plate 38. The amount in the ones numbered 2 and 3 does not show very clearly, so a short line has been drawn to one side of each to indicate the quantity.

PLATE 39.

The attention of trainmen is particularly called to the exhibits shown in Plate 39. No. 1 is a retaining-valve with the exhaust hole plugged, and No. 2 is a retaining-

valve pipe, which, because the valve was missing, was plugged with a piece of wood. Both of these were taken from cars on which the brake was reported "stuck," and had to be bled off after every application or else remained stuck all the time.

From some imperfection in the quick-action part of the triple-valve there was a constant blow from the retaining-valve or pipe, which some uninstructed brakeman stopped in the manner shown.

### Plate 40.

The most striking curiosity in the air-brake line the author has ever seen is illustrated in Plate 40. It is a car drain-cup, broken open to show the interior, into which some one has stuffed a heavy woolen cloth and pine stick, crushing the screen all to pieces, and almost completely filling the whole of the cavity. It was found just in the condition shown, when the brake came to be overhauled under a general order to examine all the drain-cups, and how it got into such a remarkable condition is a mystery. It is possible some one tried to clean out the cylindrical screen by forcing the woolen rag through with the stick, and that the stick became caught, and not being able to get it out, the pipe was coupled up in a hurry and nothing said about it.

Synnestvedt, Paul.
Diseases of the air brake system; their causes, symptoms and cure, by Paul Synnestvedt. Chicago, The W. F. Hall Printing Company, 1894.
114 p. diagrs. 20 cm.